# The Advantages of Angle of Attack Indicators in General Aviation Aircraft

THESIS

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By

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Abstract

The General Aviation Joint Steering Committee (GAJSC), a government and aviation industry representative, conducted a detailed analysis of fatal general aviation accidents for the period 2001–2010 and found that 50% indicated loss of control as a contributing factor. A loss of control occurs when an aircraft stalls and the control surface movements made by the pilot no longer control the airplane until the stall recovery is initiated. As an aircraft flies, the smooth airflow overtop the wing creates a low pressure area, and the airflow underneath a high pressure area. This pressure differential generates lift. When this airflow is disrupted, the aircraft loses lift very suddenly and a stall is said to occur. Looking deeper into stalls involves a look at what is called the Angle of Attack. This is the angle between the chord line of the wing (a line connecting the leading most point on the wing with the trailing most point) and the flight path of the aircraft. The Angle of Attack changes throughout different phases of flight, but a stall will always occur when the Critical Angle of Attack is exceeded. Though the aerodynamics behind and recovery procedures for stalls are taught extensively in private pilot training, there is no instrument in standard general aviation cockpits that indicate the aircraft's angle of attack. Instead, student pilots are taught cues related to an impending stall which they can gather from standard instruments in the cockpit.

Though not a standard piece of equipment, Angle of Attack indicators are available for purchase through several manufacturers. These indicators vary in their

presentation, but all convey the same information. However, that pilot would find that there is a relatively small amount of information available to them on how to operate their aircraft more safely with the equipment. This study will address the overall benefit of an Angle of Attack Indicator and its intuitiveness. By comparing the performance of pilots using an Angle of Attack Indicator who have received training on its operation and function with those who receive no formal training, it will become clear if education is necessary for pilots to achieve better operational performance and safety.

The research findings showed little variance in the performance between pilots with training on the Angle of Attack Indicator system and without, but much can still be gained from the results. Future experiments can isolate other variables at play in this experiment and attempt to explain why the Angle of Attack Indicators did not seem to offer any distinct advantage in this research project.

# Dedication

This document is dedicated to the aviation students at the Ohio State University

## Acknowledgments

I would like to acknowledge Seth Young, Shawn Pruchnicki, Marshall Pomeroy, and the research staff at Purdue University and Florida Institute of Technology for their contributions to the project, without which I would not have been able to write this thesis.

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## Fields of Study

Major Field: Aviation

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# Chapter 1: Introduction

The General Aviation Joint Steering Committee (GAJSC), an organization which works to improve general aviation safety through data-driven risk reduction efforts, completed a study which found that 50% of fatal general aviation accidents were attributed to a loss of control. A loss of control in this circumstance means a stall, where the flow of air around a wing results in a rapid reduction in lift, or a spin, where one wing stalls more than the other and results in a descending helical path. This illuminates a need for change when it comes to loss of control recovery. In order to reduce fatalities and decrease the loss of life, the ability of general aviation pilots to perceive an impending stall must be addressed. In recent years, there has been much talk about the Angle of Attack Indicators, which provide much more direct information to the pilot regarding how much excess lift the aircraft wings can produce before the critical angle of attack is reached and a stall occurs. These indicators produce a display based on the aircraft's angle of attack by measuring the pressure difference between the air flowing underneath the wing and the static air around the aircraft.

An angle of attack is defined as the angle between the chord line of the wing (a line connecting the leading most point on the wing with the trailing most point) and the flight path of the aircraft. The Angle of Attack changes throughout different phases of flight. The Critical Angle of Attack is reached when "smooth airflow over the airplane's wing is disrupted, and the lift degenerates rapidly" (Airplane Flying Handbook). Though most general aviation aircraft are manufactured without such a device due to the added cost (roughly $2500 for the system utilized in this experiment), their potential safety benefits may make the extra cost worthwhile (Alpha

Systems Operating Manual). Conventional methods of teaching stalls and stall recovery involve certain cues to indicate an impending stall. These cues can include low airspeed, as the angle of attack is increased to compensate for loss of thrust when the throttle is reduced, and control buffeting as the air flow begins to separate from the wing. The reliance on conventional methods of teaching is dangerous in the fact that that said cues may not occur before the critical angle of attack is reached. Additionally, maneuvers which increase the load factor (g-forces) on the wings such as turns increase the stall speed, rendering the ability to predict an oncoming stall solely by reference to airspeed difficult. The figure below indicates the increase in stall speed for given increases in g-forces placed upon a wing

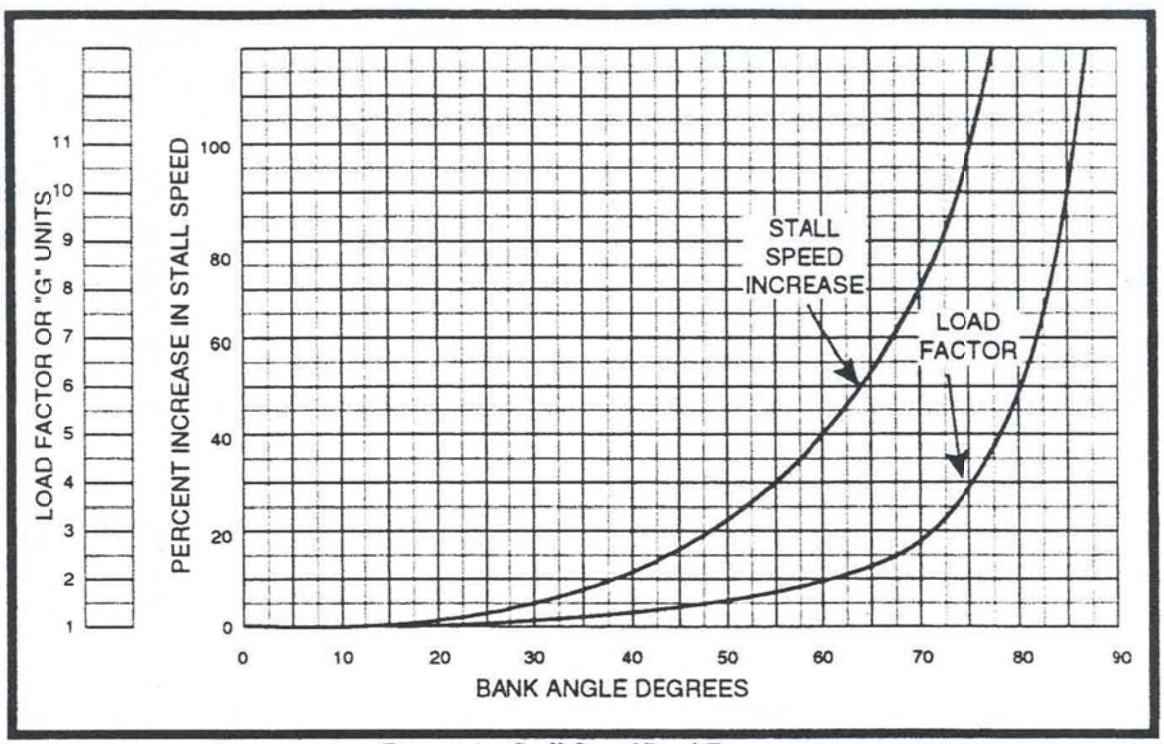


Figure 1: Percent Increase in Stall Speed versus Increase in Load Factor

Though this is the way most students are taught, stalls can occur at any airspeed if a strong enough load is placed on the aircraft wings. Therefore, pilots have no way to gauge exactly how much higher the stall speed will be for a given increase in wing loading. Though not a fundamental instrument used to train pilots, the information Angle of Attack Indicators displays to the pilot may be significant enough to reduce the number of loss of control accidents, as its lighting configurations will alert the pilot when the wing angle of attack is getting close to the Critical Angle of Attack. This research study, incorporating the use of two flight training aircraft and approximately forty pilots, will answer the question of the indicator's impact on airspeed control during final descent to landing. The proper angle of attack on final approach to landing coincides with a specific airspeed of the aircraft. Using an indicator which indicates to the pilot when he or she is holding that proper angle of attack should allow the pilot to maintain the approach airspeed with less tolerance.

## Chapter 2: Aircraft Equipment

Two main pieces of equipment were required for the experiment to be completed. This equipment, an Angle of Attack Indicator and a flight data recorder, was provided to the Ohio State University Center for Aviation Studies as a part of a PEGASAS research project. The Partnership to Enhance General Aviation Safety, Accessibility, and Security (PEGASUS) is an FAA sponsored consortium of colleges which focus on increasing safety in the general aviation industry.

One such project studied the correlation between Angle of Attack Indicator usage and steady descent rates on approach. This project analyzed the descent rates of aircraft on final approach in an attempt to see if those who were received training on and were able to utilize Angle of Attack Indicators flew more stable approaches, or those with more constant vertical speeds. In order to best use resources and attain significant amounts of data with limited funds, this project used the same equipment and data provided for the PEGASAS project. The Angle of Attack Indicator used for this project, the Legacy model by Alpha Systems, was the company's bestselling model as of summer 2013.. At a cost of around $1,200, the system offers great potential benefits for a relatively low cost. The Legacy model indicator, shown below in Figure 2, displays nine different lighting configurations which indicate the aircraft's angle of attack continuously throughout the flight. In cruise flight, where the angle of attack is significantly smaller than the critical angle of attack, only the blue bar on the bottom of the indicator is illuminated. As the angle of attack increases, the illuminated lights move upwards until reaching the red chevrons, indicating a stall. The portion of the Operating Manual which addresses these displays can be found in the Appendix. Figure 3 shows the probe installation for the indicator, which is located on the underside of the left wing of the aircraft.


Figure 2: Alpha Systems Legacy Model Cockpit Indicator

**Figure 3**: Alpha Systems Legacy Model Angle of Attack Indicator Probe

The flight data recorder, manufactured by CAPACG, is a device that records such flight metrics as latitude and longitude, groundspeed, altitude, and vertical speed. The recorder records these parameters twice per second, a picture of which is provided in Figure 4 below. Certain limits on the data recorder's ability to record all flight parameters were taken into account during the experimental design phase, which can be seen in the next section.

Figure 4: CAPACG Flight Data Recorder

Two aircraft were utilized in the experiment, both of which are owned by the Ohio State University. The aircraft used were Piper Arrows, which are complex aircraft. A complex aircraft has retractable landing gear, flaps, and a controllable pitch propeller.

## Chapter 3: Study Methodology

As stated in the introduction, the main goal of the study was to determine the correlation between Angle of Attack Indicator usage and airspeed control during approach to landing. Many of the design specifics mirror those found in the FAA funded PEGASAS Angle of Attack project, as that allowed a much greater and more meaningful amount of data to be analyzed. Therefore, the methodology for the PEGASAS project is described below.

In order to study the effect Angle of Attack Indicator usage on airspeed control during final descent to landing, four groups were developed which pilot participants would randomly be assigned. These groups can be found in Table 1. Not only will the results show whether or not Angle of Attack Indicators aided pilots in flying much more precise airspeeds, but also whether or not receiving educational training on the systems proved beneficial.

| Participant Groupings | Description |
|---|---|
| Group 1 | Received training and had access to the Angle of Attack display during flight |
| Group 2 | Received training but did not have access to the Angle of Attack display during flight |
| Group 3 | Did not receive training but had access to the Angle of Attack display during flight |
| Group 4 | Did not receive training and did not have access to the Angle of Attack display during flight |

Table 1: Participant Groups

For the purposes of this study, “training” was a 30 minute presentation on the aerodynamics of stalls, the identification of the numerous lighting configurations on the indicator and what they mean to the pilot, and how to properly utilize the indicator in the cockpit. Training also involved the completion of basic maneuvers (such as climbing, descending, turning, and both power on and power off stalls) and a total of six landings, all with an Angle of Attack Indicator. Three airports were utilized in the study. The first two airports where landings were to be performed were Delaware Municipal Airport (KDLZ) and Union County Airport (KMRT), small airports located about 10 miles north and northwest of the Ohio State University Airport (KOSU), respectively. The purpose of using these two airports was to have participants fly landing approaches into airports they may not be incredibly familiar with. If a student has flown in the local traffic pattern of an airport numerous times, they may resort to flying it in the same way during the study. By utilizing other airports which they are less familiar with, their performance will be the result of their training, or lack thereof, on the Angle of Attack Indicator system.

The data recorder in the aircraft collected several pieces of data twice per second throughout the entire flight. The data analyzed for the study was that which was produced when the aircraft, on approach to land, was between 500 feet above the ground and the surface. This parameter, for the average approach, represents the final portion of the approach where the aircraft is aligned with the runway and flying at the proper approach speed. If performed, the completion of training maneuvers was simply to allow the participant to see the Angle of Attack Indicator and gain knowledge on the system operation. So, any participant with training would have watched an educational video, performed basic maneuvers in flight, and performed six landings all with the Angle of Attack Indicator. The testing for each group required only one flight, except Group 2 which required two flights, because the pilot does not have access to an Angle of Attack Indicator during the data collection flight but does during the training flight.

The data analysis of flights in Groups 1 and 4 will determine the value of training on and access to an Angle of Attack Indicator. Group 4 is the control group, so it is important to compare the performance of those in Group 1 to those in Group 4. If there is no significant difference between the performances, then there is no advantage to having training in and access to an Angle of Attack Indicator. Group 2 will serve to determine the value of the training module and flight, as the participant will not be able to use the indicator during the flight where data was analyzed. The data collected from this group will show if the training on stalls and the Critical Angle of Attack has any advantage on flying without an Angle of Attack Indicator. Group 3 will determine how intuitive the device is, as they will attempt to use it in flight having no prior knowledge on its operation. Information from this study may be crucial to the industry, and may lead to the development of training modules for Angle of Attack Indicator systems is they are found to be a significant factor in the performance of pilots.

The pilot requirements to participate in the study were a Private Pilot License, the first license most pilots receive, and between 50 and 250 total flight hours. Those requirements were chosen as they represent the average pilot who is licensed yet does not have a large amount of experience at the controls of an aircraft. Any pilot interested in participating in the study was eligible as long as the experience requirements were met, although a majority of those in the study are pilots in the aviation program at the Ohio State University. The original plan was to place forty pilots randomly between the four groups, though time constraints on the project resulted in only 22 participant flights completed.

The data analyzed after each flight was that produced during the final approach before each landing, from 500 feet above the surface to the surface. Certain limits of the CAPACG data recorder, such as it only being capable of recording the groundspeed of the aircraft, were taken into account when deciding how to record the approaches. Though pilot's fly an approach based on a certain indicated airspeed, a speed relative to the air itself which does not take wind into account, the actual speed of an aircraft on approach relative to the ground will change from day to day as the wind changes. In other words, an approach with a strong headwind will result in a slower ground speed than one with no headwind, even though both approaches were flown at the same indicated airspeed. The flight data recorder has no way of recording the indicated airspeed shown to the pilot, but uses GPS location and time to determine the aircraft speed over the ground. Therefore, finding the average ground speed of all approaches in a given group and comparing them would not yield useful data as different ground speeds for each data recording flight may be the result of different winds and not pilot skill. Using this information, it was decided that the best way to determine a pilot's ability to hold a steady approach speed was to determine the standard deviation for each approach. By doing so, the calculation will reveal how much a pilot's airspeed fluctuated during the final descent. A high standard deviation would represent greater airspeed fluctuations than a smaller value, and therefore less airspeed control. This assumes a constant wind from an altitude of 500 feet to the surface, which is not considered an extreme assumption. Though the wind will change slightly during the final portion of the descent on an average day, this assumption is not considered extreme and will not have significant effect on the data results. In order to obtain the most accurate results, go-arounds, approaches where the aircraft is unstable and results in a balked landing, would be disregarded as the airspeed would remain much higher than one which results in a landing. After the standard deviation of airspeed was calculated for each approach, the math for which can be seen in the appendix, each standard deviation value for the entire group was added up and divided by the number of approaches to determine an average value for the standard deviation.

Based on the experimental design established, the following three hypothesis were developed:

1. Pilots with AOA training and access to and AOA will conduct approaches to landing with greater airspeed control
2. Pilots with AOA training will conduct approaches to landing with greater airspeed control even without the use of an AOA indicator
3. Pilots with AOA indicator access will conduct approaches to landing with greater airspeed control even without training on the system

# Chapter 4: Findings

| | Group 1 | Group 2 | Group 3 | Group 4 |
|---|---|---|---|---|
| Standard Deviation Approach Average | 4.64 knots | 8.06 knots | 7.19 knots | 6.33 knots |
| Number of Approaches | 6 | 43 | 26 | 37 |
| Number of Participants | 1 | 8 | 5 | 7 |

Table 2: Cumulative Data Findings

The experimental findings can be found in the table below. The two data values found associated with each group are the standard deviation approach average by the pilots in that particular group, as well as the number of approaches analyzed in each group. The approach numbers between each group differ due to time constraints on the project, a few equipment issues, and the decision not to analyze go-arounds. Looking strictly at the average standard deviation data, it appears that the pilot from Group 1 maintained airspeed within the closest parameters, followed by Group 4, then Group 3, then Group 2. These results support the first hypothesis, but not the second or third. Group 1, whose pilots received training and were able to use the AOA indicator, performed the best of all other groups. However, it must be noted that only 6 approaches were analyzed in this group, significantly less than the number analyzed in the other three groups. The next best performing group was Group 4, the control group. This is surprising as the pilots in this group flew the aircraft without the aid of training or the indicator during approaches. However, it is important to note that the data from groups 2,3, and 4 are all within 1.73 knots of each other, a relatively low number given a normal approach speed of 73 knots. This does not show any major difference in performance between the four groups.

## Chapter 5: Conclusion

Though the experiment did not find conclusive evidence regarding the aid of Angle of Attack Indicators in the cockpit of general aviation aircraft, there is much to take away from the results. Numerous variables may explain why no conclusive evidence was found, such as the type of aircraft used in the experiment. To begin with, completing more flights to bring the total approach number of Group 1 to the level of the other groups will allow the results to hold more value. The pilot participant responsible for the Group 1 data may have been either well above or well below average skill, therefore resulting in data that may not replicate the data seen if several pilots had been in that group. Another explanation for the results may be the type of aircraft flown in the study. The Piper Arrow is a complex aircraft, meaning it has retractable landing gear, flaps, and a constant speed propeller. Only two of the participants in the study had prior complex aircraft experience, so many may have felt uncomfortable in the new aircraft to the extent that they were more focused on flying the aircraft than utilizing the indicator. Performing this experiment in an aircraft type which most of the participants have prior experience in may result in more conclusive evidence and show the indicator's ability to help participants hold a more constant airspeed on approach. One last thought on the reason behind the lack of conclusive evidence in the study is the fact that gathering data after only one flight with the Angle of Attack Indicator may simply be asking too much of the pilots. The participants, none of whom indicated they regularly flew an aircraft with a similar angle of attack device, learned how to manipulate the aircraft in response to other stimuli and instrument readings. Introducing them to this new equipment to see how they react to it in one flight may have resulted in them ignoring the device and focusing on only the instruments and procedures they are used to. Introducing a change like this may take several flights to get the participant comfortable with the device, at which point collecting data on the flight may yield much different results. Additionally, changes to the research methodology, such as a new educational module or different experience requirements for participants, may lead to more conclusive results as well. This paves the way for future research on the topic, where the effect of individual variables can be tested to see their overall impact on Angle of Attack Indicator usage.

References

Installation and Operations Manual for the “Legacy” Angle of Attack (AOA) Indicator. (2010, October 28). Retrieved September 14, 2014.

*Airplane Flying Handbook*. Washington, D.C.: U.S. Dept. of Transportation, Federal Aviation Administration, Flight Standards Service, 2004. Print.

*Angle of Attack Equipment in General Aviation Operations*. FAA Report, December 2014

Appendix A: Legacy Model Lighting Display Overview

**No Segments** = Power **Off** or no lift, no pressure information in which the computer can display an output or on the ground with no movement.

**1.)** **Red Chevrons** = Extremely low or no lift / Critical Alpha, stall, loss of controllable lift, AOA extremely high, large correction required immediately, aircraft in uncontrollable descent. Perform stall recovery procedures.

**2.)** **Red Chevrons + top half of Green Circle (Top half of Doughnut)** = Possible stall, very high AOA, loss of control surface effectiveness, descending, major instant AOA correction required.

**3.)** **Top half of Green Circle (Top half of Doughnut) only** = Slight loss of lift, not able to hold altitude, descending, high AOA, possible slight loss of rudder, aileron, elevator control effectiveness, not enough lift to take off or even hold altitude.

**4.)** **Complete Green Circle (Green Doughnut)** = **OAA** (Optimum Alpha Angle), calibrated set point indicating minimum controllable with zero sink, full aileron, elevator, rudder control, slow flight, very minimal aircraft climb capability, just enough lift to hold altitude, complete aircraft flight dynamic effectiveness.

**5.)** **Bottom Half of Green Circle (Green Doughnut)** = Slightly lower AOA, max climb angle, highest AOA allowing somewhat of a slow climb, full control surface effectiveness. A small amount of additional available lift. Pilot prepare to correct or add additional lift if conditions / situation requires. Very little climb reserve.

**6.)** **Bottom Half of Green Circle (Green Doughnut) + Yellow Chevron** = Lower AOA, not much climb reserve, able to sustain a continued climb, complete and full directional control and stability.

**7.)** **Yellow Chevron** – Increase in climb rate possible, additional available lift, half way between **Cruise** and **OAA** set points. Complete aircraft control authority. Pilot to be aware of the amount of lift / AOA depending on the in-flight situation and the lift requirements. Able to make good climb rates, descent corrections with full control.

**8.)** **Yellow Chevron + Blue Bar** = Top end of the slow flight AOA indication, plenty of lift, significant increase in climb possible, just starting to loose lift, begin paying attention to AOA. Just under the maximum amount of lift or lowest AOA

**9.)** **Blue Bar** = Calibrated set point for **Cruise** of the aircraft, lowest AOA, **lots of lift**, indication capable of unlimited climb.

Appendix B: Sample Group 1Participant Data Calculation

| Groundspeed (Knots) | Vertical Speed (feet/min) | Altitude | | | |
|---|---|---|---|---|---|
| APPROACH 1 | | | | | |
| 78.4 | -436.3 | 1493.1 | | AVG STD | 4.640833 |
| 77.3 | -382 | 1487.2 | | | |
| 76 | -349.7 | 1481.9 | | | |
| 74.8 | -331.2 | 1477 | | | |
| 73.7 | -356 | 1471.5 | | | |
| 73.2 | -403.3 | 1464.8 | | | |
| 73 | -457.6 | 1456.4 | | | |
| 72.8 | -504.1 | 1446.9 | | | |
| 72.7 | -526.9 | 1437.2 | | | |
| 72.4 | -532.4 | 1427.7 | | | |
| 71.9 | -531.6 | 1418.4 | | | |
| 71.5 | -528.9 | 1409 | | | |
| 71.1 | -532.8 | 1399.7 | | | |
| 70.7 | -551.7 | 1390 | | | |
| 70.2 | -578.9 | 1379.5 | | | |
| 70.4 | -581.6 | 1369 | | | |
| 71 | -591.5 | 1358.9 | | | |
| 71.9 | -598.6 | 1349.1 | | | |
| 72.4 | -603.3 | 1339.2 | | | |
| 72.9 | -597.4 | 1329.8 | | | |
| 73.3 | -580.5 | 1320.7 | | | |
| 73.6 | -569.8 | 1312.3 | | | |
| 73.8 | -573.4 | 1303.7 | | | |
| 74.5 | -572.6 | 1294.7 | | | |
| 75.1 | -553.3 | 1285.9 | | | |
| 75.4 | -545 | 1277.7 | | | |
| 76.1 | -538.7 | 1269.9 | | | |
| 76.3 | -509.2 | 1262.2 | | | |
| 76.1 | -470.2 | 1255.1 | | | |

| | | | | | |
|---|---|---|---|---|---|
| 75.5 | -414.7 | 1249.1 | | | |
| 74.5 | -355.2 | 1244.8 | | | |
| 73.5 | -305.2 | 1241.5 | | | |
| 72.3 | -275.3 | 1238.8 | | | |
| 71.7 | -265.4 | 1236.4 | | | |
| 71.3 | -252 | 1233.8 | | | |
| 70.8 | -275.7 | 1230.1 | | | |
| 70.8 | -324.9 | 1224 | | | |
| 70.7 | -335.5 | 1216.9 | | | |
| 70.7 | -336.7 | 1209.8 | | | |
| 70.5 | -330.4 | 1202.9 | | | |
| 70.2 | -334.7 | 1196.9 | | | |
| 71.2 | -324.9 | 1191.7 | | | |
| 71.5 | -300.1 | 1187.8 | | | |
| 71.8 | -277.2 | 1185.1 | | | |
| 71.9 | -235.9 | 1184 | | | |
| 71.4 | -220.9 | 1183 | | | |
| 71.3 | -209.5 | 1181.8 | | | |
| 71.1 | -180 | 1181.2 | | | |
| 71.3 | -172.1 | 1181.1 | | | |
| 71.5 | -156.7 | 1180.8 | | | |
| 71.8 | -137.4 | 1181.2 | | | |
| 72.2 | -131.5 | 1181.1 | | | |
| 71.8 | -110.7 | 1181.4 | | | |
| 72.3 | -130.7 | 1180.4 | | | |
| 72.2 | -166.6 | 1177.8 | | | |
| 72 | -209.5 | 1173 | | | |
| 71.7 | -235.9 | 1166.9 | | | |
| 71.3 | -291.8 | 1158.9 | | | |
| 71.6 | -315 | 1149.9 | | | |
| 71.6 | -324.1 | 1141.2 | | | |
| 71.6 | -324.5 | 1132.9 | | | |
| 71.7 | -319.8 | 1124.3 | | | |
| 71.3 | -312.7 | 1115 | | | |
| 70.8 | -302.8 | 1105.9 | | | |
| 70 | -317 | 1096.5 | | | |
| 70 | -320.2 | 1087.2 | | | |
| 70.1 | -334.7 | 1078.2 | | | |
| 69.8 | -341 | 1069.9 | | | |
| 68.9 | -362.7 | 1061.4 | | | |
| 68.7 | -381.6 | 1052.4 | | | |

| | | | | | |
|---|---|---|---|---|---|
| 68.5 | -393 | 1043.4 | | | |
| 68.1 | -411.1 | 1034.5 | | | |
| 67.7 | -426.5 | 1025.5 | | | |
| 67 | -434 | 1016.5 | | | |
| 65.9 | -454.1 | 1007.4 | | | |
| 65.3 | -469 | 997.7 | | | |
| 64 | -460.4 | 987.9 | | | |
| 62.4 | -431.6 | 978.4 | | | |
| 60.5 | -392.6 | 969.5 | | | |
| 58.5 | -353.6 | 961.5 | | | |
| 56.5 | -302.8 | 955 | | | |
| 71.15802469 | Average Groundspeed | | | | |
| 3.674910346 | Standard Deviation | | | | |
| | | | | | |
| APPROACH 2 | | | | | |
| 70.4 | -474.5 | 1494.9 | | | |
| 70.2 | -499.7 | 1485.6 | | | |
| 69.8 | -499.3 | 1476.5 | | | |
| 69.6 | -521 | 1467.4 | | | |
| 69.6 | -565.1 | 1457 | | | |
| 70 | -601.3 | 1446.3 | | | |
| 70.3 | -621.8 | 1435.8 | | | |
| 70.1 | -641.9 | 1424.4 | | | |
| 71 | -668.7 | 1412 | | | |
| 72.1 | -706.1 | 1398.7 | | | |
| 73.4 | -745.1 | 1384.2 | | | |
| 75.6 | -785.2 | 1368.4 | | | |
| 77 | -804.5 | 1352 | | | |
| 76.8 | -819.5 | 1335.3 | | | |
| 77 | -793.1 | 1319.4 | | | |
| 75.3 | -739.6 | 1305.5 | | | |
| 75.3 | -655.7 | 1294.5 | | | |
| 74.8 | -579.3 | 1286.5 | | | |
| 74.6 | -545.8 | 1280 | | | |
| 74.5 | -542.3 | 1273.8 | | | |
| 74.8 | -573 | 1266.3 | | | |
| 75.5 | -563.9 | 1257.9 | | | |
| 75.2 | -533.6 | 1250 | | | |
| 75.3 | -526.9 | 1242.8 | | | |
| 75.6 | -543.4 | 1234.7 | | | |
| 75.8 | -536.7 | 1225.7 | | | |

| | | | | | |
|---|---|---|---|---|---|
| 76.3 | -526.9 | 1217.1 | | | |
| 76.4 | -502.9 | 1209.2 | | | |
| 75.6 | -449.7 | 1203.1 | | | |
| 74.6 | -410.3 | 1198.5 | | | |
| 73.8 | -375.7 | 1194.1 | | | |
| 72.8 | -336.7 | 1197.1 | | | |
| 72.3 | -311.9 | 1196.4 | | | |
| 71.8 | -309.9 | 1193.7 | | | |
| 71.6 | -293.4 | 1192.8 | | | |
| 72.6 | -259.5 | 1192.8 | | | |
| 72.3 | -231.6 | 1192.8 | | | |
| 71.8 | -223.7 | 1190.9 | | | |
| 71.6 | -257.5 | 1186 | | | |
| 72.1 | -317.8 | 1178.1 | | | |
| 72.9 | -345.4 | 1171.5 | | | |
| 73 | -377.7 | 1164 | | | |
| 72.7 | -398.1 | 1155.7 | | | |
| 72.2 | -393 | 1148 | | | |
| 71.8 | -394.2 | 1142.1 | | | |
| 71.6 | -383.2 | 1137.4 | | | |
| 71.3 | -380.8 | 1133.4 | | | |
| 71.3 | -387.5 | 1127.8 | | | |
| 71 | -404.8 | 1121.2 | | | |
| 70.8 | -407.6 | 1113.6 | | | |
| 70.3 | -408.8 | 1106.2 | | | |
| 69.9 | -386.3 | 1100.3 | | | |
| 69.7 | -361.1 | 1094.8 | | | |
| 69.8 | -356 | 1089.2 | | | |
| 69.9 | -369.4 | 1082.7 | | | |
| 69.9 | -395 | 1074.7 | | | |
| 70 | -406.4 | 1065.6 | | | |
| 69.9 | -378.8 | 1056.4 | | | |
| 69.7 | -356 | 1047.8 | | | |
| 69.8 | -360.7 | 1038.6 | | | |
| 70 | -363.1 | 1029 | | | |
| 69.5 | -355.6 | 1019.9 | | | |
| 68.4 | -359.5 | 1010.8 | | | |
| 67.6 | -370.6 | 1001.3 | | | |
| 65.8 | -347.3 | 991.7 | | | |
| 63.8 | -304 | 979.6 | | | |
| 61.6 | -257.2 | 967.7 | | | |

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|---|---|---|---|---|---|
| 59.7 | -220.5 | 961.8 | | | |
| 57.7 | -185.1 | 956.6 | | | |
| 55.9 | -161.9 | 952.1 | | | |
| 71.32428571 | Average Groundspeed | | | | |
| 4.14496152 | Standard Deviation | | | | |
| | | | | | |
| APPROACH 3 | | | | | |
| 71.3 | -281.2 | 1497.4 | | | |
| 70.4 | -288.7 | 1491.5 | | | |
| 69.9 | -333.9 | 1485 | | | |
| 70 | -385.9 | 1477.6 | | | |
| 70.4 | -432 | 1469.2 | | | |
| 70.6 | -470.6 | 1460 | | | |
| 71.3 | -477.3 | 1450.6 | | | |
| 71.2 | -481.6 | 1441.5 | | | |
| 71 | -489.5 | 1432 | | | |
| 70.7 | -466.7 | 1422.8 | | | |
| 70.3 | -444.2 | 1414.2 | | | |
| 69.3 | -390.3 | 1406.8 | | | |
| 68.5 | -353.6 | 1400.2 | | | |
| 67.8 | -334.7 | 1394 | | | |
| 67.6 | -317 | 1387.5 | | | |
| 66.9 | -324.9 | 1380.9 | | | |
| 66.3 | -336.7 | 1374.3 | | | |
| 68.3 | -353.6 | 1367.8 | | | |
| 68.6 | -394.6 | 1360.5 | | | |
| 69.1 | -432.4 | 1351.9 | | | |
| 69.7 | -491.5 | 1342.5 | | | |
| 70.6 | -565.1 | 1331.6 | | | |
| 71.3 | -606.5 | 1317.8 | | | |
| 71.4 | -655.3 | 1302.5 | | | |
| 71.7 | -683.6 | 1290.2 | | | |
| 72.1 | -685.6 | 1277.4 | | | |
| 72.1 | -666.3 | 1265.4 | | | |
| 72 | -638 | 1254.7 | | | |
| 71.6 | -596.6 | 1246.1 | | | |
| 71 | -571 | 1237.3 | | | |
| 71 | -566.3 | 1227.9 | | | |
| 71 | -569.8 | 1218 | | | |
| 70.7 | -541.5 | 1209.4 | | | |
| 70.1 | -518.6 | 1200.7 | | | |

| | | | | | |
|---|---|---|---|---|---|
| 69.5 | -502.1 | 1192.8 | | | |
| 69 | -461.5 | 1186.6 | | | |
| 68.6 | -432 | 1181.9 | | | |
| 68.1 | -426.5 | 1175.9 | | | |
| 68.1 | -439.9 | 1168.4 | | | |
| 68.2 | -461.1 | 1160.2 | | | |
| 68.3 | -473 | 1151.4 | | | |
| 68.4 | -489.9 | 1141.7 | | | |
| 68.6 | -483.6 | 1132.9 | | | |
| 68.5 | -471.8 | 1124.7 | | | |
| 68.7 | -438.7 | 1116.8 | | | |
| 68.2 | -382.8 | 1110 | | | |
| 68.1 | -339.8 | 1104.9 | | | |
| 67.8 | -325.7 | 1100.3 | | | |
| 67.9 | -322.9 | 1095.8 | | | |
| 67.9 | -326.5 | 1090.7 | | | |
| 68 | -320.9 | 1085.4 | | | |
| 67.9 | -315 | 1080 | | | |
| 68 | -320.2 | 1074.6 | | | |
| 68.3 | -316.6 | 1069.6 | | | |
| 68.6 | -336.3 | 1064.2 | | | |
| 68.7 | -359.9 | 1058.1 | | | |
| 68.9 | -355.6 | 1052 | | | |
| 68.9 | -341 | 1046.3 | | | |
| 68.3 | -332 | 1040.6 | | | |
| 67.5 | -339.5 | 1035 | | | |
| 66.7 | -360.3 | 1028.9 | | | |
| 65.6 | -353.2 | 1022.8 | | | |
| 63.3 | -326.9 | 1017.2 | | | |
| 61.6 | -268.2 | 1012.9 | | | |
| 59.7 | -193 | 1010.2 | | | |
| 57.1 | -154.8 | 1008.5 | | | |
| 55.6 | -133.1 | 1007.1 | | | |
| 68.54328358 | Average Groundspeed | | | | |
| 3.101037162 | Standard Deviation | | | | |
| | | | | | |
| APPROACH 4 | | | | | |
| 77 | -743.5 | 1487.9 | | | |
| 75.9 | -718.7 | 1475.9 | | | |
| 75.1 | -718.3 | 1463.4 | | | |
| 74.4 | -725.8 | 1450.2 | | | |

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|---|---|---|---|---|---|
| 73.7 | -762.4 | 1436.3 | | | |
| 72.5 | -795.9 | 1421.5 | | | |
| 72.8 | -828.2 | 1406.3 | | | |
| 74 | -863.2 | 1391 | | | |
| 76.3 | -942.4 | 1372.2 | | | |
| 76.6 | -1010.5 | 1351.6 | | | |
| 76.8 | -1042.8 | 1331.8 | | | |
| 77.3 | -1045.1 | 1313.1 | | | |
| 78.7 | -1014.8 | 1296.4 | | | |
| 80.4 | -997.9 | 1280.3 | | | |
| 81.8 | -975.4 | 1264.8 | | | |
| 83.5 | -927.4 | 1250.1 | | | |
| 85.5 | -877.8 | 1235.6 | | | |
| 87.5 | -816.3 | 1222.4 | | | |
| 87.7 | -730.9 | 1211.6 | | | |
| 87.7 | -649 | 1203 | | | |
| 87.3 | -551.7 | 1196.6 | | | |
| 85.8 | -441.4 | 1192.8 | | | |
| 84 | -348.1 | 1191.5 | | | |
| 81.7 | -225.6 | 1193 | | | |
| 78.9 | -106.3 | 1197.6 | | | |
| 76.6 | 4.3 | 1204.5 | | | |
| 73.4 | 72.1 | 1212.6 | | | |
| 71.1 | 117.7 | 1220.5 | | | |
| 68.5 | 168.5 | 1229.3 | | | |
| 66.9 | 156.7 | 1237.5 | | | |
| 65.3 | 128.4 | 1243.8 | | | |
| 64.2 | 82.3 | 1247.8 | | | |
| 65.4 | 13 | 1248.9 | | | |
| 65.7 | -81.1 | 1246.5 | | | |
| 66.7 | -175.6 | 1240.6 | | | |
| 68.8 | -300.1 | 1231 | | | |
| 70.6 | -415.1 | 1217.7 | | | |
| 71 | -505.2 | 1202.6 | | | |
| 71.5 | -590.3 | 1186.4 | | | |
| 71.8 | -656.1 | 1169.3 | | | |
| 71.9 | -632.4 | 1152.8 | | | |
| 71.4 | -595.4 | 1137.5 | | | |
| 70.7 | -568.3 | 1122.9 | | | |
| 69.8 | -535.2 | 1109.1 | | | |
| 69.5 | -505.2 | 1096.9 | | | |

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|---|---|---|---|---|---|
| 69.1 | -486.7 | 1086.4 | | | |
| 68.5 | -494.6 | 1076.9 | | | |
| 68.7 | -497.4 | 1067.9 | | | |
| 68.7 | -503.3 | 1059.1 | | | |
| 68.3 | -489.5 | 1050.3 | | | |
| 68 | -458.4 | 1042.2 | | | |
| 67.9 | -460.7 | 1033.9 | | | |
| 67.3 | -419.4 | 1025.7 | | | |
| 66.4 | -382 | 1018.6 | | | |
| 65.3 | -374.5 | 1011.8 | | | |
| 64.2 | -381.6 | 1005.1 | | | |
| 62.3 | -366.6 | 998.4 | | | |
| 60.8 | -310.7 | 993.2 | | | |
| 59.1 | -246.5 | 989.6 | | | |
| 57.4 | -175.6 | 988.1 | | | |
| 55.7 | -105.1 | 988.6 | | | |
| 72.48196721 | Average Groundspeed | | | | |
| 7.668365932 | Standard Deviation | | | | |
| | | | | | |
| APPROACH 5 | | | | | |
| 89.5 | -905.3 | 1497.2 | | | |
| 89.2 | -894.3 | 1479.1 | | | |
| 89.2 | -868.7 | 1462.4 | | | |
| 89 | -835.2 | 1447.2 | | | |
| 88.7 | -781.7 | 1434.1 | | | |
| 88.5 | -730.1 | 1422.4 | | | |
| 88.2 | -741.1 | 1409.8 | | | |
| 87.9 | -775.8 | 1395.7 | | | |
| 88.2 | -794.3 | 1380.8 | | | |
| 88.2 | -829.7 | 1364.8 | | | |
| 88.3 | -875.4 | 1347.5 | | | |
| 88.3 | -895.1 | 1330.1 | | | |
| 87.7 | -844.3 | 1315.2 | | | |
| 86.4 | -795.9 | 1302 | | | |
| 85.5 | -760.4 | 1290.2 | | | |
| 84.5 | -701.4 | 1279.8 | | | |
| 84.1 | -641.5 | 1269.9 | | | |
| 83.4 | -599.4 | 1261.2 | | | |
| 82.9 | -592.7 | 1253 | | | |
| 82.6 | -605.3 | 1244.4 | | | |
| 81.9 | -621 | 1235.5 | | | |

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|---|---|---|---|---|---|
| 80.5 | -597 | 1226.7 | | | |
| 79.4 | -573.4 | 1218.8 | | | |
| 78.2 | -541.5 | 1210.9 | | | |
| 77.4 | -505.6 | 1203.8 | | | |
| 76.9 | -474.1 | 1197.2 | | | |
| 76.5 | -480.4 | 1190.6 | | | |
| 76 | -494.6 | 1183.4 | | | |
| 75.5 | -505.2 | 1175.9 | | | |
| 75 | -489.1 | 1168.4 | | | |
| 74.6 | -450.1 | 1161.9 | | | |
| 74.1 | -398.5 | 1156.2 | | | |
| 73.7 | -355.6 | 1151.4 | | | |
| 73.5 | -351.7 | 1146.7 | | | |
| 73.4 | -368.2 | 1141.3 | | | |
| 73 | -391.4 | 1135.5 | | | |
| 72.6 | -411.1 | 1129.3 | | | |
| 72.2 | -399.3 | 1123.1 | | | |
| 71.8 | -391.8 | 1117.4 | | | |
| 71.4 | -372.1 | 1111.9 | | | |
| 71.2 | -355.6 | 1107 | | | |
| 70.6 | -345 | 1102 | | | |
| 70.1 | -338.3 | 1097.1 | | | |
| 69.9 | -358.4 | 1091.5 | | | |
| 69.6 | -365.8 | 1085.5 | | | |
| 69.6 | -376.1 | 1079.1 | | | |
| 69.7 | -396.2 | 1072.5 | | | |
| 69.8 | -409.9 | 1065.6 | | | |
| 69.7 | -407.2 | 1058.9 | | | |
| 70 | -410.7 | 1052.2 | | | |
| 70.1 | -449.3 | 1044.9 | | | |
| 70.2 | -472.6 | 1036.5 | | | |
| 70.4 | -454.8 | 1028.2 | | | |
| 70.5 | -460 | 1020 | | | |
| 70.6 | -447.8 | 1011.8 | | | |
| 70.7 | -461.1 | 1003.9 | | | |
| 70.6 | -464.7 | 995.4 | | | |
| 70.3 | -465.5 | 987.2 | | | |
| 69.9 | -462.7 | 979.3 | | | |
| 69.6 | -470.6 | 971.5 | | | |
| 68.5 | -487.5 | 963 | | | |
| 67.2 | -461.9 | 954.7 | | | |

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|---|---|---|---|---|---|
| 65.7 | -438.3 | 947 | | | |
| 64.3 | -402.5 | 940 | | | |
| 62.5 | -364.3 | 933.5 | | | |
| 60.7 | -315.4 | 928.1 | | | |
| 58.6 | -278.4 | 923.6 | | | |
| 57.2 | -227.2 | 919.6 | | | |
| 55.5 | -173.7 | 916.9 | | | |
| 75.52463768 | Average Groundspeed | | | | |
| 8.779511674 | Standard Deviation | | | | |
| | | | | | |
| APPROACH 6 | | | | | |
| 74.8 | -583.2 | 1491.1 | | | |
| 73.4 | -595.4 | 1479.9 | | | |
| 72.3 | -593.9 | 1469 | | | |
| 71.3 | -608 | 1458.2 | | | |
| 70.8 | -652.5 | 1446.3 | | | |
| 70.4 | -682.5 | 1433.5 | | | |
| 70.2 | -713.2 | 1419.9 | | | |
| 70.4 | -739.2 | 1405.6 | | | |
| 70.8 | -750.2 | 1391.5 | | | |
| 70.9 | -775.8 | 1377 | | | |
| 70.7 | -804.1 | 1361.7 | | | |
| 70.5 | -835.6 | 1345.4 | | | |
| 70.6 | -884.1 | 1327.8 | | | |
| 70.4 | -899.4 | 1309.4 | | | |
| 70.1 | -879.4 | 1291.7 | | | |
| 69.7 | -855.7 | 1274.4 | | | |
| 69.4 | -853.8 | 1257.4 | | | |
| 69.5 | -866 | 1240.4 | | | |
| 69.6 | -882.9 | 1223.2 | | | |
| 69.7 | -880.1 | 1206.1 | | | |
| 69.9 | -866.4 | 1189.4 | | | |
| 69.8 | -821.1 | 1173.9 | | | |
| 70 | -771.5 | 1159.8 | | | |
| 69.9 | -727 | 1146.8 | | | |
| 70.2 | -699.8 | 1134.4 | | | |
| 70.2 | -686.4 | 1122.5 | | | |
| 70.5 | -656.9 | 1111 | | | |
| 70.6 | -615.1 | 1100.5 | | | |
| 70.8 | -579.3 | 1090.5 | | | |
| 70.8 | -547 | 1081.3 | | | |

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|---|---|---|---|---|---|
| 70.8 | -549 | 1072.2 | | | |
| 71.1 | -541.1 | 1063.1 | | | |
| 71.4 | -526.5 | 1054.1 | | | |
| 71.4 | -497.8 | 1045.6 | | | |
| 71.8 | -472.2 | 1037.6 | | | |
| 72.2 | -439.5 | 1030.2 | | | |
| 72.6 | -426.5 | 1023.5 | | | |
| 72.7 | -439.5 | 1016.2 | | | |
| 73.1 | -429.6 | 1009 | | | |
| 73.1 | -397.7 | 1002.4 | | | |
| 73 | -372.9 | 996.8 | | | |
| 72.9 | -371.7 | 991.5 | | | |
| 72.9 | -391.8 | 985.5 | | | |
| 72.7 | -415.1 | 978.5 | | | |
| 72.5 | -422.5 | 971.3 | | | |
| 72.3 | -449.3 | 963.6 | | | |
| 71.5 | -447 | 955.6 | | | |
| 70.7 | -437.9 | 948 | | | |
| 69.9 | -465.5 | 939.9 | | | |
| 68.9 | -483.2 | 931.1 | | | |
| 67.5 | -463.5 | 922.6 | | | |
| 65.4 | -417.4 | 915.1 | | | |
| 63.4 | -350.5 | 909.2 | | | |
| 61.7 | -300.9 | 904.8 | | | |
| 60.3 | -244.5 | 901.4 | | | |
| 58.6 | -192.6 | 899 | | | |
| 56.6 | -151.6 | 897.3 | | | |
| 69.98596491 | Average Groundspeed | | | | |
| 3.503744864 | Standard Deviation | | | | |

Appendix C: Sample Group 2 Participant Data Calculation

| Groundspeed | Vertical Speed (feet/min) | Altitude | | | |
|---|---|---|---|---|---|
| Approach 1 | | | | | |
| 83.8 | -456 | 1499.5 | | AVG STD | 6.223939 |
| 83.7 | -474.9 | 1490.9 | | | |
| 83 | -463.1 | 1483.1 | | | |
| 81.7 | -424.9 | 1476.7 | | | |
| 80.3 | -380.8 | 1471.4 | | | |
| 79.1 | -342.6 | 1466.4 | | | |
| 77.8 | -333.9 | 1460.9 | | | |
| 76.5 | -359.9 | 1454.4 | | | |
| 75.3 | -368.2 | 1447.8 | | | |
| 74.5 | -358.4 | 1442.1 | | | |
| 73.6 | -356.4 | 1436.2 | | | |
| 72.7 | -379.2 | 1429.1 | | | |
| 72.3 | -409.2 | 1422.6 | | | |
| 71.8 | -439.9 | 1415.5 | | | |
| 71.8 | -477.7 | 1405.8 | | | |
| 71.8 | -519.8 | 1394.6 | | | |
| 72.5 | -568.6 | 1381.8 | | | |
| 71.9 | -620.2 | 1367.5 | | | |
| 71.4 | -664.7 | 1352 | | | |
| 71.6 | -719.9 | 1335 | | | |
| 72.7 | -798.6 | 1314.9 | | | |
| 73.9 | -893.5 | 1292.3 | | | |
| 74 | -949.8 | 1270.4 | | | |
| 73.6 | -905.7 | 1253.5 | | | |
| 72.6 | -847.9 | 1238.5 | | | |
| 72 | -783.7 | 1225.1 | | | |
| 71.2 | -729.7 | 1212.7 | | | |
| 70.6 | -675.8 | 1201.2 | | | |
| 70.3 | -630.5 | 1190.5 | | | |
| 70 | -653.7 | 1177.8 | | | |
| 70.3 | -703.3 | 1163.3 | | | |

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|---|---|---|---|---|---|
| 70.4 | -750.2 | 1147.8 | | | |
| 70 | -805.3 | 1131 | | | |
| 70.4 | -853 | 1113.6 | | | |
| 72 | -916.4 | 1094.5 | | | |
| 72.8 | -931.7 | 1076.4 | | | |
| 72.8 | -917.2 | 1059.8 | | | |
| 73 | -873.1 | 1044.9 | | | |
| 72.9 | -812.4 | 1031.6 | | | |
| 72.3 | -752.9 | 1019.5 | | | |
| 71.7 | -686.8 | 1008.9 | | | |
| 71.3 | -624.6 | 999.4 | | | |
| 70.5 | -562.7 | 990.9 | | | |
| 69.2 | -499.3 | 983.7 | | | |
| 67.4 | -439.9 | 977.2 | | | |
| 65.3 | -381.2 | 971.6 | | | |
| 63.5 | -321.7 | 967.3 | | | |
| 61.4 | -252.8 | 964.1 | | | |
| 59.4 | -188.2 | 962.2 | | | |
| 57.6 | -146.5 | 960.6 | | | |
| 55.8 | -108.3 | 959.6 | | | |
| 71.92156863 | Average Groundspeed | | | | |
| 5.676030787 | Standard Deviation | | | | |
| | | | | | |
| Approach 2 | | | | | |
| 79.9 | -532 | 1497.8 | | | |
| 78.8 | -552.1 | 1487.2 | | | |
| 78 | -599.4 | 1475 | | | |
| 77.7 | -643.9 | 1461.7 | | | |
| 77.5 | -688.8 | 1447.4 | | | |
| 77.2 | -747 | 1432 | | | |
| 77.5 | -790 | 1416.5 | | | |
| 77.7 | -830.1 | 1400.6 | | | |
| 77.2 | -867.1 | 1384.3 | | | |
| 76.4 | -896.7 | 1368.1 | | | |
| 76 | -911.3 | 1350.9 | | | |
| 75.8 | -921.9 | 1333.9 | | | |
| 75.3 | -949.5 | 1316.2 | | | |
| 75 | -974.3 | 1298.2 | | | |
| 74.9 | -1007.7 | 1279.7 | | | |
| 74.8 | -1019.5 | 1261.3 | | | |
| 74.7 | -986.9 | 1244.6 | | | |

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| 74.3 | -960.1 | 1228.4 | | | |
| 73.9 | -940 | 1212.3 | | | |
| 73.3 | -912 | 1196.9 | | | |
| 72.5 | -906.9 | 1181.3 | | | |
| 72 | -870.3 | 1166.8 | | | |
| 71.5 | -813.6 | 1153.7 | | | |
| 70.5 | -764.4 | 1141.3 | | | |
| 69.4 | -755.7 | 1128.5 | | | |
| 68.9 | -789.6 | 1114.3 | | | |
| 69.4 | -818.7 | 1099.7 | | | |
| 69.3 | -847.5 | 1084.1 | | | |
| 69.3 | -892.4 | 1067.1 | | | |
| 69.4 | -913.6 | 1050.1 | | | |
| 69.1 | -873.1 | 1035.4 | | | |
| 68.2 | -807.7 | 1022.5 | | | |
| 67 | -741.1 | 1010.9 | | | |
| 65.8 | -677.7 | 1000.3 | | | |
| 64.5 | -620.6 | 990.6 | | | |
| 62.8 | -552.1 | 982.2 | | | |
| 61.8 | -482.4 | 975.1 | | | |
| 59.7 | -424.9 | 968.9 | | | |
| 57.2 | -355.6 | 964.2 | | | |
| 55.3 | -282.4 | 961.2 | | | |
| 71.4875 | Average Groundspeed | | | | |
| 6.087363435 | Standard Deviation | | | | |
| | | | | | |
| Approach 3 | | | | | |
| 86.2 | -632 | 1497.3 | | | |
| 86.6 | -616.3 | 1487.2 | | | |
| 84.6 | -597.8 | 1477.4 | | | |
| 83.1 | -578.9 | 1468 | | | |
| 82.4 | -560 | 1459.1 | | | |
| 84 | -543.8 | 1450.5 | | | |
| 85.2 | -546.2 | 1440.9 | | | |
| 85.2 | -563.5 | 1430.2 | | | |
| 84.7 | -597.4 | 1417 | | | |
| 84.2 | -597.8 | 1404.7 | | | |
| 83.7 | -594.6 | 1393.8 | | | |
| 82.7 | -567.1 | 1384.4 | | | |
| 81.8 | -532.8 | 1375.8 | | | |
| 80.9 | -490.3 | 1368.8 | | | |

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|---|---|---|---|---|---|
| 80.3 | -447 | 1362.5 | | | |
| 79.5 | -431.2 | 1356.7 | | | |
| 78.9 | -431.2 | 1351.3 | | | |
| 78.4 | -446.6 | 1344 | | | |
| 77.7 | -492.2 | 1335 | | | |
| 77.4 | -548.6 | 1324.5 | | | |
| 76.8 | -592.3 | 1313.5 | | | |
| 76.5 | -620.6 | 1302.2 | | | |
| 76 | -638.7 | 1291.5 | | | |
| 75.6 | -667.5 | 1279.9 | | | |
| 75.4 | -720.3 | 1265.7 | | | |
| 74.5 | -734.4 | 1251.8 | | | |
| 73.7 | -736.4 | 1237.8 | | | |
| 72.9 | -745.9 | 1223.6 | | | |
| 72.3 | -754.5 | 1209.5 | | | |
| 72.3 | -782.1 | 1194.9 | | | |
| 72.1 | -829.3 | 1179.6 | | | |
| 71.9 | -872.7 | 1163.2 | | | |
| 72.7 | -908.9 | 1146.4 | | | |
| 73 | -880.5 | 1131.1 | | | |
| 73 | -832.9 | 1117.1 | | | |
| 72.8 | -762 | 1104.7 | | | |
| 73.1 | -711.6 | 1093.2 | | | |
| 73.1 | -662 | 1082.3 | | | |
| 72.6 | -593.9 | 1072.8 | | | |
| 71.9 | -552.1 | 1064 | | | |
| 71.4 | -544.2 | 1054.7 | | | |
| 70.1 | -541.9 | 1043.7 | | | |
| 68.7 | -507.6 | 1033.9 | | | |
| 67 | -472.6 | 1025.4 | | | |
| 65.2 | -408.8 | 1018.8 | | | |
| 63.5 | -351.7 | 1013.3 | | | |
| 62.1 | -291.4 | 1009.6 | | | |
| 59.4 | -231.6 | 1007.4 | | | |
| 57.6 | -177.6 | 1006 | | | |
| 55.7 | -124.4 | 1005.5 | | | |
| 75.208 | Average Groundspeed | | | | |
| 7.536329426 | Standard Deviation | | | | |
| | | | | | |
| Approach 4 | | | | | |
| 76.3 | -924.2 | 1485.5 | | | |

| | | | | | |
|---|---|---|---|---|---|
| 75.6 | -955.8 | 1467.3 | | | |
| 75.3 | -992.4 | 1448.4 | | | |
| 75.4 | -1027.8 | 1428.8 | | | |
| 75.6 | -1060.9 | 1408.6 | | | |
| 76.8 | -1099.5 | 1387.5 | | | |
| 77.7 | -1153 | 1365.1 | | | |
| 77.8 | -1207.4 | 1341.2 | | | |
| 77.8 | -1205.8 | 1319.1 | | | |
| 78.2 | -1172.7 | 1298.8 | | | |
| 77.7 | -1131.8 | 1279.7 | | | |
| 76.1 | -1080.6 | 1261.9 | | | |
| 74.2 | -1014.4 | 1246.4 | | | |
| 72.5 | -949.8 | 1233.6 | | | |
| 71.5 | -863.6 | 1224.4 | | | |
| 70.4 | -775.8 | 1216.9 | | | |
| 70.2 | -691.5 | 1210.2 | | | |
| 69.3 | -659.6 | 1201.7 | | | |
| 68.6 | -679.7 | 1190.8 | | | |
| 68 | -715.5 | 1178.8 | | | |
| 67.8 | -758.5 | 1165.7 | | | |
| 67.7 | -808.5 | 1151.4 | | | |
| 67.6 | -830.5 | 1137.6 | | | |
| 68 | -857.7 | 1122.3 | | | |
| 67.9 | -866 | 1106.6 | | | |
| 67.4 | -851 | 1092.3 | | | |
| 66.7 | -799.4 | 1079.7 | | | |
| 66.2 | -733.3 | 1068.5 | | | |
| 65.7 | -665.5 | 1058.3 | | | |
| 64.6 | -597 | 1049.5 | | | |
| 63.6 | -526.9 | 1041.9 | | | |
| 62.8 | -465.9 | 1035.2 | | | |
| 61.7 | -427.3 | 1028.2 | | | |
| 60.5 | -369.8 | 1022.8 | | | |
| 59.3 | -318.2 | 1018.6 | | | |
| 57.5 | -255.6 | 1015.7 | | | |
| 56.2 | -196.9 | 1013.8 | | | |
| 69.62702703 | Average Groundspeed | | | | |
| 6.225871142 | Standard Deviation | | | | |
| | | | | | |
| Approach 5 | | | | | |
| 86.5 | -886.8 | 1493.7 | | | |

| | | | | | |
|---|---|---|---|---|---|
| 83.6 | -936.9 | 1475.7 | | | |
| 81.4 | -973.9 | 1457.7 | | | |
| 80.3 | -996.3 | 1440.8 | | | |
| 79.4 | -1026.6 | 1424.1 | | | |
| 78.9 | -1060.1 | 1405.6 | | | |
| 78.9 | -1043.6 | 1388.3 | | | |
| 78.4 | -991.2 | 1373 | | | |
| 78.1 | -996.3 | 1356.6 | | | |
| 78 | -1055 | 1337.9 | | | |
| 77.6 | -1129 | 1317.6 | | | |
| 77.3 | -1194.4 | 1296.1 | | | |
| 76.8 | -1233.8 | 1274.3 | | | |
| 76.2 | -1226.7 | 1252.8 | | | |
| 75.4 | -1173.5 | 1232.9 | | | |
| 74.8 | -1102.2 | 1214.8 | | | |
| 74.4 | -1055 | 1197.2 | | | |
| 73.8 | -1032.1 | 1179.4 | | | |
| 73 | -1004.2 | 1162.4 | | | |
| 72.2 | -996.7 | 1145.5 | | | |
| 71.8 | -1045.9 | 1127 | | | |
| 71.7 | -1127.8 | 1106.5 | | | |
| 71.5 | -1211.3 | 1084.4 | | | |
| 71.6 | -1286.5 | 1061.2 | | | |
| 72.7 | -1356.6 | 1036.7 | | | |
| 73.3 | -1353.5 | 1013.3 | | | |
| 73.5 | -1290.5 | 992 | | | |
| 73.1 | -1206.6 | 972.4 | | | |
| 72.3 | -1125.5 | 954.5 | | | |
| 71.3 | -1048.7 | 938.3 | | | |
| 69.8 | -966.8 | 924 | | | |
| 68.3 | -882.9 | 911.5 | | | |
| 66.8 | -788.8 | 901.4 | | | |
| 65.2 | -671 | 894.5 | | | |
| 63 | -541.1 | 890.8 | | | |
| 60.9 | -400.5 | 890.6 | | | |
| 59.2 | -274.5 | 891.4 | | | |
| 57.7 | -157.1 | 893.3 | | | |
| 55.8 | -75.6 | 895.5 | | | |
| 72.93589744 | Average Groundspeed | | | | |
| 6.873231339 | Standard Deviation | | | | |
| | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Approach 6 | | | | | |
| 78.9 | -813.2 | 1499.2 | | | |
| 78.3 | -798.2 | 1486.1 | | | |
| 77.7 | -817.5 | 1472.2 | | | |
| 77.4 | -858.1 | 1457.3 | | | |
| 76.9 | -857.3 | 1442.7 | | | |
| 76.4 | -834.5 | 1428.9 | | | |
| 75.6 | -825 | 1415.1 | | | |
| 74.8 | -814 | 1401.4 | | | |
| 74.1 | -804.1 | 1388 | | | |
| 73.4 | -836.4 | 1373.6 | | | |
| 73.2 | -895.5 | 1357.9 | | | |
| 72.9 | -967.2 | 1340.6 | | | |
| 72.9 | -1032.1 | 1322.4 | | | |
| 73 | -1075.5 | 1303.6 | | | |
| 73 | -1076.6 | 1285.3 | | | |
| 72.7 | -1045.1 | 1267.8 | | | |
| 72.5 | -999.1 | 1251.3 | | | |
| 72.3 | -985.3 | 1234.9 | | | |
| 71.8 | -983.7 | 1218.4 | | | |
| 71.3 | -1013.6 | 1200.9 | | | |
| 70.9 | -1032.9 | 1183.5 | | | |
| 70.4 | -1076.3 | 1165.6 | | | |
| 70 | -1130.6 | 1146.2 | | | |
| 69.7 | -1180.6 | 1125.8 | | | |
| 69.6 | -1231.8 | 1104.2 | | | |
| 69.7 | -1301.1 | 1081 | | | |
| 70.3 | -1374 | 1056.5 | | | |
| 71 | -1422 | 1031.2 | | | |
| 71.3 | -1394.4 | 1007.7 | | | |
| 71.1 | -1326.7 | 986 | | | |
| 70.8 | -1267.6 | 965.4 | | | |
| 69.9 | -1199.5 | 946.3 | | | |
| 69.4 | -1124.3 | 928.7 | | | |
| 68.1 | -1049.1 | 912.9 | | | |
| 66.3 | -957.3 | 900 | | | |
| 64.4 | -852.2 | 889.5 | | | |
| 62.5 | -734.8 | 882.2 | | | |
| 60.8 | -589.9 | 879.3 | | | |
| 58.9 | -446.2 | 878.9 | | | |
| 56.8 | -293.8 | 881.2 | | | |

| | | | | | |
|---|---|---|---|---|---|
| 71.025 | Average Groundspeed | | | | |
| 4.9448108 | Standard Deviation | | | | |

Appendix D: Sample Group 3 Participant Data Calculation

| Ground Speed (Knots) | Vertical Speed (feet per minute) | Altitude | | | |
|---|---|---|---|---|---|
| APPROACH 1 | | | | | |
| 77.9 | -566.7 | 1495.5 | | AVG STD | 7.522564 |
| 76.1 | -561.6 | 1484.8 | | | |
| 76.3 | -556.8 | 1474.9 | | | |
| 77.1 | -583.6 | 1462.8 | | | |
| 76.5 | -632 | 1448.6 | | | |
| 76.9 | -702.1 | 1431.2 | | | |
| 78.9 | -793.1 | 1411 | | | |
| 79.2 | -838.8 | 1393.2 | | | |
| 79.4 | -862 | 1374.9 | | | |
| 79.5 | -839.2 | 1358.5 | | | |
| 79.3 | -812 | 1343.8 | | | |
| 79.2 | -763.2 | 1330.8 | | | |
| 78.9 | -727.3 | 1318.2 | | | |
| 78.5 | -684.4 | 1306.4 | | | |
| 77.8 | -658.4 | 1294.9 | | | |
| 77.2 | -645.8 | 1283.7 | | | |
| 76.8 | -625.4 | 1273 | | | |
| 76.5 | -622.6 | 1262.2 | | | |
| 76.1 | -625.7 | 1251.1 | | | |
| 76.1 | -634 | 1240 | | | |
| 75.7 | -669.9 | 1227.7 | | | |
| 75.7 | -703.3 | 1214.5 | | | |
| 75.4 | -730.5 | 1201.1 | | | |
| 75.3 | -697.8 | 1189.2 | | | |
| 74.4 | -648.6 | 1179.3 | | | |
| 73.3 | -599.4 | 1170.6 | | | |
| 72.1 | -577.3 | 1161.4 | | | |
| 71.5 | -584.8 | 1151.4 | | | |
| 71.1 | -604.1 | 1140.5 | | | |
| 70.9 | -619.1 | 1129.3 | | | |
| 71 | -632.4 | 1117.8 | | | |

| | | | | | |
|---|---|---|---|---|---|
| 71.4 | -645.4 | 1106.3 | | | |
| 71.7 | -640.7 | 1095.1 | | | |
| 71.6 | -636.4 | 1084 | | | |
| 71.9 | -635.6 | 1073 | | | |
| 71.8 | -645.4 | 1061.5 | | | |
| 72.1 | -641.5 | 1050.4 | | | |
| 72.3 | -630.1 | 1039.4 | | | |
| 72.4 | -611.6 | 1029 | | | |
| 72.5 | -613.1 | 1018.4 | | | |
| 72.4 | -606.8 | 1007.9 | | | |
| 72.2 | -576.9 | 998.3 | | | |
| 71.8 | -562.7 | 988.6 | | | |
| 71.3 | -530.1 | 980.1 | | | |
| 70.9 | -478.9 | 972.8 | | | |
| 70.2 | -414.7 | 967.2 | | | |
| 69.2 | -342.2 | 962.9 | | | |
| 67.9 | -270.9 | 959.9 | | | |
| 66.7 | -219.7 | 957.5 | | | |
| 65.6 | -179.2 | 955.4 | | | |
| 64.4 | -134.3 | 954.3 | | | |
| 62.8 | -93.3 | 953.9 | | | |
| 61.4 | -78 | 953.1 | | | |
| 60.2 | -66.6 | 952.7 | | | |
| 59 | -60.3 | 952 | | | |
| 57.5 | -39.8 | 951.8 | | | |
| 56.4 | -28 | 951.6 | | | |
| 55.4 | -18.5 | 951.4 | | | |
| 72.13103448 | Average Groundspeed | | | | |
| 6.120434765 | Standard Deviation | | | | |
| | | | | | |
| APPROACH 2 | | | | | |
| 94.1 | -990.8 | 1492.7 | | | |
| 94.3 | -945.9 | 1477.5 | | | |
| 94.2 | -901 | 1462.3 | | | |
| 94.1 | -878.2 | 1446.6 | | | |
| 93.5 | -880.5 | 1430.1 | | | |
| 92.7 | -883.7 | 1413.8 | | | |
| 92.3 | -895.5 | 1397.3 | | | |
| 91.9 | -912.8 | 1380.6 | | | |
| 91.8 | -932.1 | 1363.8 | | | |
| 91.6 | -964 | 1346.4 | | | |

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|---|---|---|---|---|---|
| 91.2 | -994 | 1328.7 | | | |
| 90.8 | -1010.5 | 1311.4 | | | |
| 89.8 | -1008.9 | 1294.4 | | | |
| 89.1 | -978.2 | 1278.5 | | | |
| 88.6 | -943.5 | 1263.8 | | | |
| 87.9 | -918.7 | 1249 | | | |
| 87.4 | -914.8 | 1233.5 | | | |
| 86.7 | -910.9 | 1217.8 | | | |
| 85.7 | -916.4 | 1201.8 | | | |
| 84.6 | -925.8 | 1185.7 | | | |
| 84 | -916 | 1170 | | | |
| 83.9 | -905 | 1154.9 | | | |
| 83.7 | -919.9 | 1138.9 | | | |
| 83.5 | -921.5 | 1123 | | | |
| 83.2 | -901 | 1107.8 | | | |
| 82.9 | -866.8 | 1093.7 | | | |
| 82.5 | -850.2 | 1079.4 | | | |
| 81.9 | -827.4 | 1065.7 | | | |
| 81.4 | -771.8 | 1053.5 | | | |
| 80.2 | -700.6 | 1043 | | | |
| 78.5 | -647.4 | 1033.5 | | | |
| 77.7 | -584.8 | 1025.5 | | | |
| 77.1 | -507.2 | 1019.4 | | | |
| 76 | -495 | 1011.8 | | | |
| 75.4 | -509.6 | 1003.3 | | | |
| 75.1 | -500.9 | 995.1 | | | |
| 74.9 | -506.4 | 986.7 | | | |
| 74.6 | -506 | 978.3 | | | |
| 74 | -491.5 | 970.3 | | | |
| 73.5 | -441.1 | 963.8 | | | |
| 72.5 | -371 | 958.9 | | | |
| 71.3 | -292.2 | 955.8 | | | |
| 70 | -229.6 | 953.6 | | | |
| 68.9 | -178 | 951.9 | | | |
| 67.8 | -129.6 | 951.1 | | | |
| 66.6 | -93.3 | 950.7 | | | |
| 65.4 | -74 | 950.3 | | | |
| 63.7 | -57.9 | 950.3 | | | |
| 62.4 | -41.3 | 950.3 | | | |
| 61 | -26.8 | 950.3 | | | |
| 59.7 | -17.3 | 950.5 | | | |

| | | | | | |
|---|---|---|---|---|---|
| 59.1 | -14.2 | 950.5 | | | |
| 80.475 | Average Groundspeed | | | | |
| 10.28335558 | Standard Deviation | | | | |
| | | | | | |
| APPROACH 3 | | | | | |
| 74.1 | -517.1 | 1492.4 | | | |
| 74.2 | -556.4 | 1479.9 | | | |
| 74.5 | -596.6 | 1466.4 | | | |
| 74.8 | -646.2 | 1451.6 | | | |
| 75 | -710.8 | 1434.9 | | | |
| 75 | -756.5 | 1418.3 | | | |
| 74.8 | -775.4 | 1402.6 | | | |
| 74.7 | -789.6 | 1387.1 | | | |
| 74.9 | -792.3 | 1371.9 | | | |
| 75.3 | -773.8 | 1357.9 | | | |
| 75.6 | -756.9 | 1344.4 | | | |
| 75.6 | -748.6 | 1330.6 | | | |
| 75.8 | -737.6 | 1317 | | | |
| 76.1 | -679.3 | 1305.8 | | | |
| 76.2 | -614.7 | 1295.9 | | | |
| 75.7 | -550.9 | 1287.1 | | | |
| 75.2 | -501.3 | 1279.1 | | | |
| 75 | -448.1 | 1272.4 | | | |
| 74.7 | -411.5 | 1265.7 | | | |
| 74 | -421.4 | 1257.9 | | | |
| 73.7 | -461.1 | 1248.9 | | | |
| 73.7 | -493.8 | 1239.4 | | | |
| 73.4 | -506.8 | 1230.2 | | | |
| 73.1 | -516.7 | 1220.9 | | | |
| 73 | -539.1 | 1211 | | | |
| 73.1 | -570.6 | 1200.3 | | | |
| 73 | -606.1 | 1188.8 | | | |
| 73.1 | -619.8 | 1177.6 | | | |
| 73 | -612.8 | 1166.8 | | | |
| 72.5 | -611.2 | 1156 | | | |
| 71.8 | -649 | 1144 | | | |
| 71.6 | -687.6 | 1131.2 | | | |
| 71.7 | -697.8 | 1118.7 | | | |
| 71.8 | -711.6 | 1106 | | | |
| 71.9 | -730.5 | 1092.9 | | | |
| 72.1 | -743.1 | 1079.7 | | | |

| | | | | | |
|---|---|---|---|---|---|
| 72.4 | -738 | 1066.9 | | | |
| 72.5 | -721 | 1054.5 | | | |
| 72.3 | -672.2 | 1043.6 | | | |
| 71.6 | -611.6 | 1033.9 | | | |
| 70.1 | -542.3 | 1025.6 | | | |
| 68.3 | -493.8 | 1018.3 | | | |
| 66.7 | -431.2 | 1012.8 | | | |
| 65.2 | -367.4 | 1008.9 | | | |
| 63.7 | -291.4 | 1007.7 | | | |
| 62 | -224.1 | 1006.7 | | | |
| 60.2 | -154 | 1006.6 | | | |
| 58.1 | -84.3 | 1007.7 | | | |
| 56.2 | -40.6 | 1008.2 | | | |
| 71.89795918 | Average Groundspeed | | | | |
| 4.682702647 | Standard Deviation | | | | |
| | | | | | |
| APPROACH 4 | | | | | |
| 84.6 | -567.5 | 1492.1 | | | |
| 85 | -571 | 1483.5 | | | |
| 84.6 | -602.1 | 1470.1 | | | |
| 85 | -650.2 | 1453.6 | | | |
| 85.8 | -686 | 1437 | | | |
| 87 | -702.9 | 1421.3 | | | |
| 88 | -730.1 | 1405.2 | | | |
| 88.9 | -763.6 | 1389.2 | | | |
| 89.3 | -760.8 | 1374.7 | | | |
| 89.4 | -754.1 | 1359.9 | | | |
| 89 | -714.7 | 1346.3 | | | |
| 88.3 | -675.4 | 1333.8 | | | |
| 87.5 | -630.5 | 1322.6 | | | |
| 86.8 | -582.8 | 1312.7 | | | |
| 86 | -552.5 | 1302.8 | | | |
| 85.4 | -511.9 | 1294.1 | | | |
| 84.6 | -490.7 | 1285.4 | | | |
| 84 | -480 | 1276.2 | | | |
| 83.4 | -466.7 | 1267.5 | | | |
| 83.1 | -482.4 | 1258.1 | | | |
| 82.6 | -500.5 | 1248.2 | | | |
| 82.4 | -507.6 | 1238.7 | | | |
| 82.1 | -518.6 | 1229 | | | |
| 81.6 | -546.2 | 1218.6 | | | |

| | | | | | |
|---|---|---|---|---|---|
| 81.1 | -546.6 | 1209.1 | | | |
| 80.6 | -543.4 | 1199.7 | | | |
| 79.9 | -549.7 | 1190.1 | | | |
| 79.6 | -539.5 | 1180.8 | | | |
| 79.4 | -531.2 | 1171.7 | | | |
| 79.1 | -536 | 1162.1 | | | |
| 78.7 | -528.5 | 1153.1 | | | |
| 77.8 | -547 | 1143.1 | | | |
| 77.2 | -578.9 | 1132.2 | | | |
| 76.7 | -606.5 | 1120.7 | | | |
| 76.3 | -599.4 | 1109.9 | | | |
| 75.6 | -593.5 | 1099.2 | | | |
| 75.1 | -569 | 1089.3 | | | |
| 74.5 | -528.5 | 1080.4 | | | |
| 73.7 | -487.9 | 1072.3 | | | |
| 72.8 | -472.6 | 1064.1 | | | |
| 72 | -482.8 | 1055.1 | | | |
| 71.6 | -484.8 | 1046.3 | | | |
| 70.9 | -470.2 | 1038.1 | | | |
| 70.2 | -440.7 | 1030.4 | | | |
| 69.4 | -382.4 | 1024.5 | | | |
| 68.1 | -316.6 | 1019.9 | | | |
| 66.8 | -244.5 | 1016.9 | | | |
| 65.2 | -180.4 | 1014.8 | | | |
| 63.3 | -125.2 | 1013.6 | | | |
| 61.5 | -78 | 1013.1 | | | |
| 59.4 | -44.1 | 1012.9 | | | |
| 57.3 | -16.5 | 1013.1 | | | |
| 55.1 | 3.2 | 1013.5 | | | |
| 78.1754717 | Average Groundspeed | | | | |
| 8.83656968 | Standard Deviation | | | | |
| | | | | | |
| APPROACH 5 | | | | | |
| 77.9 | -589.9 | 1492.3 | | | |
| 77.4 | -583.6 | 1482.3 | | | |
| 76.8 | -576.5 | 1472.8 | | | |
| 76.4 | -563.1 | 1463.5 | | | |
| 75.9 | -552.9 | 1454.1 | | | |
| 75.5 | -571.8 | 1443.7 | | | |
| 75.3 | -591.9 | 1432.7 | | | |
| 75.2 | -604.1 | 1421.4 | | | |

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|---|---|---|---|---|---|
| 75.1 | -630.5 | 1409.5 | | | |
| 75.2 | -669.5 | 1396.7 | | | |
| 75.5 | -678.5 | 1384.4 | | | |
| 75.4 | -679.3 | 1372.4 | | | |
| 75.4 | -694.7 | 1359.8 | | | |
| 75.4 | -710.8 | 1347 | | | |
| 75.4 | -742.7 | 1333.5 | | | |
| 75.5 | -778.5 | 1319.2 | | | |
| 76 | -788.4 | 1305.1 | | | |
| 76.3 | -781.7 | 1291.4 | | | |
| 76.2 | -769.9 | 1278.1 | | | |
| 76 | -778.5 | 1264.4 | | | |
| 76.1 | -795.1 | 1250.3 | | | |
| 76.4 | -819.9 | 1235.4 | | | |
| 76.7 | -819.9 | 1221.1 | | | |
| 76.7 | -814 | 1207.1 | | | |
| 76.8 | -804.5 | 1193.2 | | | |
| 76.9 | -807.3 | 1179.1 | | | |
| 77.3 | -817.1 | 1164.7 | | | |
| 77.5 | -820.3 | 1150.3 | | | |
| 77.8 | -818.7 | 1136.1 | | | |
| 77.7 | -803 | 1122.6 | | | |
| 77.6 | -790.4 | 1109.3 | | | |
| 77.5 | -783.3 | 1095.9 | | | |
| 78.2 | -763.6 | 1083.1 | | | |
| 79.9 | -706.5 | 1072.2 | | | |
| 81 | -651.3 | 1062.6 | | | |
| 82 | -585.6 | 1054.7 | | | |
| 82.9 | -521.8 | 1047.8 | | | |
| 83.3 | -448.1 | 1042.8 | | | |
| 84.2 | -373.3 | 1039.2 | | | |
| 85.5 | -300.1 | 1037.1 | | | |
| 86.6 | -229.6 | 1036.2 | | | |
| 87.2 | -158.3 | 1036.2 | | | |
| 87.6 | -99.6 | 1037.1 | | | |
| 87.6 | -38.2 | 1039.1 | | | |
| Go-Around | | | | | |
| APPROACH 6 | | | | | |
| 84.9 | -913.2 | 1484.8 | | | |
| 84.3 | -869.9 | 1470.6 | | | |
| 83.7 | -856.5 | 1455.6 | | | |

| | | | | | |
|---|---|---|---|---|---|
| 83 | -877 | 1439.2 | | | |
| 82.4 | -910.5 | 1421.9 | | | |
| 82.5 | -934.5 | 1404.4 | | | |
| 82.4 | -957.7 | 1386.7 | | | |
| 82.2 | -983.3 | 1368.2 | | | |
| 82.2 | -1007.3 | 1349.6 | | | |
| 82.3 | -1036.1 | 1330.3 | | | |
| 82.3 | -1075.9 | 1310.1 | | | |
| 82.2 | -1116.8 | 1289.4 | | | |
| 82.5 | -1127.4 | 1269.1 | | | |
| 82.7 | -1103.8 | 1250.6 | | | |
| 82.7 | -1094.8 | 1231.6 | | | |
| 82.7 | -1082.9 | 1212.4 | | | |
| 83 | -1038.8 | 1194.6 | | | |
| 82.4 | -983.3 | 1178.4 | | | |
| 81.5 | -936.5 | 1163 | | | |
| 80.5 | -903.8 | 1148 | | | |
| 79.6 | -881.7 | 1133.2 | | | |
| 78.9 | -875.8 | 1118.1 | | | |
| 78.3 | -877.8 | 1102.8 | | | |
| 77.7 | -871.5 | 1087.9 | | | |
| 77.2 | -858.9 | 1073.2 | | | |
| 76.7 | -846.3 | 1058.9 | | | |
| 76.3 | -835.2 | 1044.9 | | | |
| 75.9 | -825 | 1030.9 | | | |
| 75.3 | -800.2 | 1017.7 | | | |
| 74.6 | -773.4 | 1004.7 | | | |
| 73.9 | -752.6 | 992.1 | | | |
| 73.2 | -737.6 | 979.7 | | | |
| 72.7 | -723.8 | 967.3 | | | |
| 72.1 | -693.1 | 956 | | | |
| 71.5 | -663.6 | 945.1 | | | |
| 71 | -613.1 | 935.5 | | | |
| 70 | -548.6 | 927.4 | | | |
| 68.7 | -500.1 | 919.9 | | | |
| 67.4 | -469.8 | 912.8 | | | |
| 66.7 | -411.1 | 907.7 | | | |
| 65.6 | -326.9 | 904.5 | | | |
| 63.7 | -257.9 | 902 | | | |
| 62.2 | -196.5 | 900.4 | | | |
| 60.3 | -135.1 | 899.6 | | | |

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|---|---|---|---|---|---|
| 58.1 | -93.3 | 898.9 | | | |
| 56.4 | -61 | 898.5 | | | |
| 76.00869565 | Average Groundspeed | | | | |
| 7.689757288 | Standard Deviation | | | | |

Appendix E: Sample Group 4 Participant Data Calculation

| Groundspeed | Vertical Speed (ft/min) | Altitude | | | |
|---|---|---|---|---|---|
| APPROACH 1 | | | | AVG STD | 4.318422 |
| 75.3 | -545 | 1491.3 | | | |
| 74.7 | -589.9 | 1478.6 | | | |
| 74.6 | -574.9 | 1468.2 | | | |
| 74.3 | -574.6 | 1457.4 | | | |
| 74 | -587.5 | 1445.9 | | | |
| 73.7 | -597 | 1434.7 | | | |
| 73.7 | -623 | 1422.8 | | | |
| 73.9 | -660.4 | 1410 | | | |
| 74.4 | -719.1 | 1395.1 | | | |
| 74.4 | -793.9 | 1378 | | | |
| 74.3 | -823.4 | 1361.7 | | | |
| 74.2 | -832.5 | 1345.9 | | | |
| 74.2 | -850.2 | 1329.1 | | | |
| 74.2 | -849.4 | 1313.3 | | | |
| 74.2 | -835.6 | 1298.2 | | | |
| 74.1 | -830.9 | 1283.3 | | | |
| 73.6 | -830.5 | 1268.4 | | | |
| 73 | -810.4 | 1254.2 | | | |
| 72.6 | -790 | 1240.5 | | | |
| 72.1 | -771.5 | 1227.1 | | | |
| 71.4 | -729.7 | 1214.9 | | | |
| 70.9 | -662 | 1204.2 | | | |
| 70.4 | -594.2 | 1195 | | | |
| 69.4 | -528.5 | 1186.8 | | | |
| 68.7 | -466.3 | 1179.7 | | | |
| 68.4 | -451.3 | 1172.2 | | | |
| 68.1 | -498.9 | 1163.1 | | | |
| 68.1 | -551.7 | 1153 | | | |

| | | | | | |
|---|---|---|---|---|---|
| 68.1 | -607.2 | 1141.8 | | | |
| 68.4 | -604.1 | 1131.2 | | | |
| 68.7 | -601.3 | 1121 | | | |
| 68.7 | -578.1 | 1111.3 | | | |
| 68.9 | -546.2 | 1102.1 | | | |
| 68.9 | -536.7 | 1093 | | | |
| 68.7 | -554.1 | 1083.5 | | | |
| 68.4 | -540.7 | 1074.3 | | | |
| 68 | -495.8 | 1066.4 | | | |
| 67.7 | -441.8 | 1059.4 | | | |
| 67.7 | -384.3 | 1053.7 | | | |
| 67.7 | -407.2 | 1046.6 | | | |
| 67.7 | -465.1 | 1038.1 | | | |
| 67.6 | -503.7 | 1028.9 | | | |
| 68.2 | -504.9 | 1020.3 | | | |
| 68.4 | -525.3 | 1011.1 | | | |
| 68.2 | -531.6 | 1001.9 | | | |
| 67.8 | -521.8 | 993 | | | |
| 67.4 | -511.9 | 984.3 | | | |
| 67 | -473 | 976.7 | | | |
| 66.3 | -478.9 | 968.7 | | | |
| 64.9 | -479.6 | 960.4 | | | |
| 63.4 | -425.3 | 953.8 | | | |
| 62 | -381.6 | 947.8 | | | |
| 60.2 | -328.4 | 943 | | | |
| 58.5 | -259.5 | 939.8 | | | |
| 56.8 | -179.2 | 938.5 | | | |
| 55 | -114.2 | 938.1 | | | |
| 69.36071429 | Average Groundspeed | | | | |
| 4.611396104 | Standard Deviation | | | | |
| | | | | | |
| APPROACH 2 | | | | | |
| 78.3 | -554.9 | 1494.4 | | | |
| 76.3 | -512.7 | 1486.7 | | | |
| 73.7 | -473.3 | 1479.8 | | | |
| 71.4 | -428.8 | 1474.5 | | | |
| 70 | -372.5 | 1471 | | | |
| 69.6 | -316.2 | 1469 | | | |
| 70.8 | -289.4 | 1466 | | | |
| 71.8 | -283.9 | 1462.4 | | | |

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|---|---|---|---|---|---|
| 71.8 | -286.7 | 1458 | | | |
| 75.7 | -292.6 | 1452.8 | | | |
| 80.1 | -320.6 | 1445.5 | | | |
| 81.1 | -367.8 | 1436 | | | |
| 80.9 | -419 | 1425.7 | | | |
| 80.5 | -508.4 | 1411.9 | | | |
| 79.4 | -591.1 | 1396.9 | | | |
| 78.5 | -591.5 | 1385.8 | | | |
| 77.8 | -631.7 | 1372.9 | | | |
| 76.9 | -691.9 | 1358.2 | | | |
| 76 | -746.3 | 1341.9 | | | |
| 75.5 | -777.8 | 1325.6 | | | |
| 75 | -773.4 | 1310.4 | | | |
| 74.5 | -760.8 | 1296.2 | | | |
| 74.2 | -756.5 | 1282.1 | | | |
| 74.1 | -752.6 | 1268.4 | | | |
| 74.3 | -740.3 | 1254.9 | | | |
| 74.6 | -763.2 | 1240.8 | | | |
| 74.7 | -795.5 | 1225.8 | | | |
| 74.4 | -804.5 | 1211.4 | | | |
| 73.6 | -793.9 | 1197.3 | | | |
| 72.9 | -760.4 | 1184.3 | | | |
| 72 | -716.7 | 1172.3 | | | |
| 71.3 | -649.8 | 1162.1 | | | |
| 70.6 | -586.8 | 1152.9 | | | |
| 70.6 | -514.7 | 1145 | | | |
| 71.1 | -471 | 1137.5 | | | |
| 71.6 | -474.9 | 1129.1 | | | |
| 71.9 | -508 | 1119.7 | | | |
| 71.8 | -539.5 | 1109.4 | | | |
| 71.8 | -542.3 | 1099.7 | | | |
| 71.6 | -544.2 | 1090.2 | | | |
| 70.7 | -545 | 1080.7 | | | |
| 69.7 | -542.3 | 1071.2 | | | |
| 69 | -528.9 | 1062.3 | | | |
| 68.5 | -498.6 | 1054.1 | | | |
| 67.4 | -466.3 | 1046.7 | | | |
| 66.6 | -406.8 | 1040.8 | | | |
| 66.3 | -377.3 | 1035.1 | | | |
| 66.1 | -408.8 | 1027.7 | | | |
| 65.9 | -454.4 | 1019.1 | | | |

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|---|---|---|---|---|---|
| 65.1 | -458 | 1011.1 | | | |
| 64.3 | -427.7 | 1004.3 | | | |
| 63.5 | -433.6 | 996.7 | | | |
| 62.7 | -439.9 | 989.1 | | | |
| 61.3 | -447 | 981.2 | | | |
| 59.9 | -424.5 | 974.1 | | | |
| 58.6 | -406 | 967.5 | | | |
| 57.4 | -411.1 | 960.1 | | | |
| 55.7 | -378.8 | 953.9 | | | |
| 71.23103448 | Average Groundspeed | | | | |
| 5.866204335 | Standard Deviation | | | | |
| | | | | | |
| APPROACH 3 | | | | | |
| 77.6 | -649.4 | 1498.6 | | | |
| 75.8 | -630.9 | 1488.3 | | | |
| 74.3 | -598.2 | 1479.1 | | | |
| 73 | -565.1 | 1470.9 | | | |
| 72.3 | -531.6 | 1463.5 | | | |
| 72.8 | -496.2 | 1456.8 | | | |
| 74.7 | -473.7 | 1450 | | | |
| 75.6 | -488.7 | 1441.2 | | | |
| 77.3 | -522.2 | 1430.8 | | | |
| 78.7 | -577.3 | 1418.2 | | | |
| 80.1 | -626.9 | 1404.9 | | | |
| 79.8 | -609.2 | 1393.8 | | | |
| 79.2 | -545.4 | 1385.4 | | | |
| 78.8 | -552.1 | 1375.3 | | | |
| 78.2 | -587.9 | 1363.8 | | | |
| 77.7 | -617.1 | 1352.4 | | | |
| 77.1 | -637.6 | 1340.9 | | | |
| 77 | -660.4 | 1328.9 | | | |
| 77 | -683.2 | 1316.5 | | | |
| 76.7 | -697.4 | 1304.1 | | | |
| 76.4 | -686.8 | 1292.1 | | | |
| 76.5 | -660.8 | 1281.1 | | | |
| 76.6 | -679.7 | 1269 | | | |
| 76.3 | -735.2 | 1254.9 | | | |
| 76 | -791.1 | 1239.8 | | | |
| 75.3 | -809.7 | 1225 | | | |
| 74.6 | -809.7 | 1210.9 | | | |

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|---|---|---|---|---|---|
| 73.7 | -776.6 | 1198.4 | | | |
| 72.5 | -737.2 | 1186.9 | | | |
| 71.2 | -665.5 | 1177.1 | | | |
| 70.6 | -591.5 | 1168.8 | | | |
| 69.9 | -523 | 1161.4 | | | |
| 69.5 | -471.8 | 1154.5 | | | |
| 69 | -461.5 | 1147 | | | |
| 68.9 | -497 | 1138.1 | | | |
| 68.7 | -531.2 | 1128.1 | | | |
| 68.7 | -555.3 | 1117.9 | | | |
| 68.8 | -549 | 1108.6 | | | |
| 68.7 | -536.7 | 1099.6 | | | |
| 68.4 | -503.3 | 1091.6 | | | |
| 68.3 | -458 | 1084.6 | | | |
| 68.3 | -413.1 | 1078.2 | | | |
| 68.2 | -380 | 1072.4 | | | |
| 67.6 | -372.5 | 1066.1 | | | |
| 67.3 | -353.2 | 1060.4 | | | |
| 67.5 | -343 | 1054.7 | | | |
| 67.5 | -352.5 | 1048.4 | | | |
| 67.7 | -361.1 | 1042 | | | |
| 67.6 | -373.7 | 1035.2 | | | |
| 67.2 | -386.7 | 1028.4 | | | |
| 66.9 | -360.3 | 1022.6 | | | |
| 67.1 | -349.3 | 1016.9 | | | |
| 67.2 | -377.3 | 1010 | | | |
| 67.1 | -402.5 | 1002.6 | | | |
| 66.6 | -406.8 | 995.4 | | | |
| 65.8 | -392.2 | 988.7 | | | |
| 64.7 | -398.9 | 981.5 | | | |
| 63 | -371 | 975.3 | | | |
| 61.5 | -363.9 | 969.2 | | | |
| 59.6 | -344.6 | 963.3 | | | |
| 57.9 | -300.1 | 958.9 | | | |
| 56.5 | -267.8 | 955 | | | |
| 71.21129032 | Average Groundspeed | | | | |
| 5.568532927 | Standard Deviation | | | | |
| | | | | | |
| APPROACH 4 | | | | | |
| 71.5 | -515.9 | 1497.8 | | | |

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|---|---|---|---|---|---|
| 71.7 | -506.4 | 1489.2 | | | |
| 72.1 | -482 | 1481.2 | | | |
| 72.7 | -460 | 1473.7 | | | |
| 73.1 | -442.6 | 1466.3 | | | |
| 73.1 | -425.3 | 1459.3 | | | |
| 72.5 | -432.4 | 1451.7 | | | |
| 72.1 | -460.7 | 1442.8 | | | |
| 71.9 | -513.1 | 1433.1 | | | |
| 72.5 | -572.2 | 1422.1 | | | |
| 71.9 | -624.6 | 1410.8 | | | |
| 72.2 | -673.4 | 1398.4 | | | |
| 72.2 | -709.2 | 1385.2 | | | |
| 72.3 | -700.6 | 1373 | | | |
| 72.5 | -641.9 | 1362.7 | | | |
| 72.8 | -574.2 | 1354.1 | | | |
| 73 | -498.6 | 1347.2 | | | |
| 72.5 | -434.4 | 1341.3 | | | |
| 72 | -369 | 1336.5 | | | |
| 71.2 | -334.3 | 1331.6 | | | |
| 70.2 | -280.4 | 1328.1 | | | |
| 69.4 | -244.2 | 1324.9 | | | |
| 68.2 | -263.5 | 1320.5 | | | |
| 67.9 | -309.9 | 1314.8 | | | |
| 68.2 | -357.6 | 1308.2 | | | |
| 67.6 | -397.3 | 1300.9 | | | |
| 67.8 | -424.5 | 1293.3 | | | |
| 68.5 | -455.6 | 1284.6 | | | |
| 68.7 | -498.2 | 1274.5 | | | |
| 68.5 | -459.2 | 1267.1 | | | |
| 68.3 | -433.6 | 1260 | | | |
| 67.8 | -464.7 | 1251 | | | |
| 67.1 | -455.2 | 1242.3 | | | |
| 66.7 | -447.8 | 1234 | | | |
| 66.4 | -447 | 1225.7 | | | |
| 65.7 | -455.2 | 1217.7 | | | |
| 65.4 | -443.8 | 1210 | | | |
| 65.2 | -472.2 | 1201.2 | | | |
| 64.9 | -483.6 | 1192.3 | | | |
| 64.9 | -462.3 | 1184.1 | | | |
| 65 | -417.4 | 1177.2 | | | |
| 64.7 | -372.5 | 1171.1 | | | |

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| 64.3 | -356.4 | 1165.1 | | | |
| 64.2 | -388.3 | 1158 | | | |
| 65.1 | -430.8 | 1150 | | | |
| 65.2 | -442.2 | 1141.8 | | | |
| 65 | -425.3 | 1134.6 | | | |
| 65.2 | -449.7 | 1126.4 | | | |
| 65.1 | -465.5 | 1118 | | | |
| 64.8 | -431.2 | 1111 | | | |
| 64.9 | -389.1 | 1104.8 | | | |
| 64.8 | -373.3 | 1098.4 | | | |
| 64.5 | -380.4 | 1091.6 | | | |
| 63.8 | -399.7 | 1084.1 | | | |
| 63.5 | -367.4 | 1078 | | | |
| 63.3 | -365.4 | 1071.7 | | | |
| 63 | -384.3 | 1064.9 | | | |
| 62.1 | -417.4 | 1057.4 | | | |
| 60.9 | -416.6 | 1049.7 | | | |
| 59.3 | -367.4 | 1043.8 | | | |
| 58.1 | -341.8 | 1038.1 | | | |
| 56.9 | -320.9 | 1032.5 | | | |
| 55.8 | -274.1 | 1028 | | | |
| 67.34444444 | Average Groundspeed | | | | |
| 4.299766602 | Standard Deviation | | | | |
| | | | | | |
| APPROACH 5 | | | | | |
| 73.9 | -228.8 | 1497.8 | | | |
| 73.4 | -236.3 | 1493.6 | | | |
| 73.3 | -246.9 | 1488.8 | | | |
| 73.4 | -273.7 | 1482.8 | | | |
| 73.7 | -308 | 1475.3 | | | |
| 74.3 | -356.4 | 1466.5 | | | |
| 75.5 | -406 | 1457 | | | |
| 76.7 | -443.8 | 1447.2 | | | |
| 76.9 | -469.4 | 1437.5 | | | |
| 75.9 | -424.9 | 1430.7 | | | |
| 75 | -369.4 | 1425.2 | | | |
| 74.6 | -317.8 | 1421.2 | | | |
| 74.3 | -278 | 1418 | | | |
| 74.3 | -260.3 | 1414.8 | | | |
| 73.9 | -282.4 | 1410 | | | |

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| 73.7 | -320.2 | 1404.3 | | | |
| 73.3 | -382 | 1396.9 | | | |
| 73.2 | -432.4 | 1388.8 | | | |
| 72.5 | -485.6 | 1379.3 | | | |
| 71.8 | -505.6 | 1369.5 | | | |
| 71.4 | -505.2 | 1360.7 | | | |
| 70.7 | -496.2 | 1352.8 | | | |
| 70.5 | -489.9 | 1344.7 | | | |
| 70.3 | -507.6 | 1335.6 | | | |
| 70.3 | -549.7 | 1325 | | | |
| 70.3 | -591.1 | 1314 | | | |
| 70.5 | -639.1 | 1301.8 | | | |
| 70.7 | -684.8 | 1288.1 | | | |
| 71.3 | -737.2 | 1273.6 | | | |
| 71.7 | -790 | 1258.5 | | | |
| 71.7 | -802.6 | 1243.8 | | | |
| 71.6 | -761.6 | 1231.1 | | | |
| 71.4 | -694.3 | 1220.1 | | | |
| 71.4 | -621 | 1210.9 | | | |
| 71.4 | -554.9 | 1202.9 | | | |
| 71.4 | -517.8 | 1194.7 | | | |
| 71.6 | -480.8 | 1187.1 | | | |
| 71.9 | -447.4 | 1180.4 | | | |
| 72.2 | -450.1 | 1173 | | | |
| 72.2 | -448.5 | 1165.4 | | | |
| 72.3 | -428.8 | 1158.3 | | | |
| 72.2 | -407.6 | 1151.4 | | | |
| 71.8 | -391.4 | 1144.8 | | | |
| 71.5 | -381.6 | 1138.2 | | | |
| 71.5 | -383.2 | 1131.6 | | | |
| 71.6 | -377.7 | 1125.2 | | | |
| 71.3 | -394.2 | 1118.2 | | | |
| 71.2 | -363.5 | 1112.5 | | | |
| 71.6 | -360.7 | 1106.8 | | | |
| 72 | -377.7 | 1100.2 | | | |
| 71.7 | -351.3 | 1094.2 | | | |
| 71.8 | -330 | 1089.1 | | | |
| 71.9 | -343.8 | 1083.3 | | | |
| 71.3 | -359.1 | 1077.4 | | | |
| 70.4 | -395.4 | 1070 | | | |
| 69.1 | -424.5 | 1062.1 | | | |

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|---|---|---|---|---|---|
| 67.5 | -439.5 | 1054.3 | | | |
| 66 | -404 | 1047.4 | | | |
| 63.9 | -345 | 1042 | | | |
| 62.2 | -326.1 | 1036.6 | | | |
| 60.7 | -308 | 1031.8 | | | |
| 59 | -253.2 | 1028.3 | | | |
| 56.9 | -185.9 | 1026.3 | | | |
| 55.3 | -124.8 | 1025.3 | | | |
| 70.98125 | Average Groundspeed | | | | |
| 4.207773419 | Standard Deviation | | | | |
| | | | | | |
| APPROACH 6 | | | | | |
| 72.2 | -410.3 | 1498.8 | | | |
| 71.6 | -407.2 | 1492 | | | |
| 71.2 | -399.3 | 1485.5 | | | |
| 71 | -399.3 | 1478.9 | | | |
| 70.5 | -397.3 | 1472.3 | | | |
| 69.9 | -390.6 | 1465.9 | | | |
| 69.6 | -361.5 | 1460.4 | | | |
| 69.2 | -337.1 | 1455.1 | | | |
| 68.8 | -287.9 | 1451.2 | | | |
| 69.2 | -298.9 | 1446.1 | | | |
| 69.6 | -354.4 | 1439.1 | | | |
| 70.1 | -408 | 1431.4 | | | |
| 70.2 | -462.3 | 1422.7 | | | |
| 70 | -511.2 | 1413.1 | | | |
| 70.1 | -532.8 | 1403.3 | | | |
| 70 | -517.5 | 1394.4 | | | |
| 70 | -494.2 | 1386.3 | | | |
| 70.1 | -475.3 | 1378.5 | | | |
| 70.3 | -451.3 | 1371.2 | | | |
| 70.6 | -436.3 | 1364.3 | | | |
| 70.9 | -438.7 | 1357.5 | | | |
| 71.6 | -440.3 | 1351.5 | | | |
| 72.8 | -471.4 | 1344.6 | | | |
| 73.9 | -520.2 | 1336.1 | | | |
| 74.8 | -584 | 1325.4 | | | |
| 75.9 | -643.5 | 1313.2 | | | |
| 76.2 | -710 | 1299.4 | | | |
| 75.9 | -706.9 | 1286.6 | | | |

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|---|---|---|---|---|---|
| 75.8 | -643.1 | 1275.7 | | | |
| 75.7 | -570.2 | 1266.1 | | | |
| 75.9 | -498.2 | 1257.7 | | | |
| 75.7 | -429.6 | 1250.5 | | | |
| 74.9 | -384.3 | 1243.8 | | | |
| 74.1 | -321.3 | 1238 | | | |
| 72.7 | -289 | 1232.9 | | | |
| 71.5 | -309.9 | 1227.3 | | | |
| 70.5 | -333.9 | 1221.3 | | | |
| 69.8 | -376.5 | 1214.6 | | | |
| 69.3 | -426.1 | 1207 | | | |
| 68.8 | -474.1 | 1198.2 | | | |
| 68.2 | -446.2 | 1190.6 | | | |
| 67.8 | -423.7 | 1183.1 | | | |
| 67.1 | -437.9 | 1175.5 | | | |
| 66.8 | -441.8 | 1167.5 | | | |
| 66.7 | -448.9 | 1159.8 | | | |
| 66.8 | -428.8 | 1152.2 | | | |
| 66.3 | -373.3 | 1146.1 | | | |
| 65.5 | -321.7 | 1140.9 | | | |
| 64.4 | -290.2 | 1136.2 | | | |
| 63.4 | -292.2 | 1131 | | | |
| 62.3 | -306 | 1125.7 | | | |
| 61.3 | -329.2 | 1119.7 | | | |
| 60.5 | -372.1 | 1112.9 | | | |
| 59.7 | -426.5 | 1104.9 | | | |
| 59.3 | -464.7 | 1096.2 | | | |
| 59.2 | -471.8 | 1087.8 | | | |
| 59.8 | -450.5 | 1080.1 | | | |
| 60.2 | -402.5 | 1073.5 | | | |
| 60.3 | -335.9 | 1068.4 | | | |
| 60.1 | -298.5 | 1063.6 | | | |
| 60.3 | -295.7 | 1058.3 | | | |
| 60.5 | -318.2 | 1052.6 | | | |
| 60.6 | -362.3 | 1045.9 | | | |
| 60.7 | -397 | 1038.6 | | | |
| 60.9 | -414.7 | 1031.2 | | | |
| 61 | -440.7 | 1023.3 | | | |
| 61 | -421.8 | 1015.8 | | | |
| 60.8 | -405.2 | 1008.9 | | | |
| 60.3 | -370.2 | 1002.6 | | | |

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|---|---|---|---|---|---|
| 59.7 | -382.4 | 995.9 | | | |
| 59.2 | -398.9 | 988.9 | | | |
| 58.6 | -423.7 | 981.3 | | | |
| 58.6 | -441.4 | 973.3 | | | |
| 58.3 | -449.3 | 965.4 | | | |
| 58.2 | -412.7 | 958.6 | | | |
| 57.9 | -400.1 | 951.8 | | | |
| 57.7 | -425.7 | 944.6 | | | |
| 56.9 | -459.2 | 936.4 | | | |
| 56 | -466.3 | 928.7 | | | |
| 66.63037975 | Average Groundspeed | | | | |
| 5.968256938 | Standard Deviation | | | | |